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Wpływ pandemii COVID-19 na popyt na pieniądz gotówkowy i zmiany w zachowaniach płatniczych: zbiór badań empirycznych

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Spis treści

Część 1.

Autoreferat

1.1. Wprowadzenie — uzasadnienie wyboru tematu

Zjawisko systematycznego wzrostu wartości gotówki w obiegu — zarówno w ujęciu nominalnym, jak i w relacji do PKB — pomimo malejącego jej wykorzystania do celów transakcyjnych, znane jest w literaturze jako „paradoks banknotów" (ang. *paradox of banknotes*) lub „paradoks gotówki" (ang. cash paradox) (por. Bailey, 2009; Gresvik & Kaloudis, 2001; Jiang & Shao, 2020; Pietrucha & Gulewicz, 2022; Rogoff, 1998). Badania wskazują, że wzrost popytu na pieniądz gotówkowy wynika m.in. z braku zaufania do sektora bankowego, niskich stóp procentowych oraz skali gospodarki nieformalnej (por. Ashworth & Goodhart, 2020; Chen et al., 2020; Pietrucha, 2021; Skibińska-Fabrowska, 2023). Z kolei sukcesywny spadek wykorzystania pieniądza gotówkowego do celów transakcyjnych wynika m.in. ze wzrostu atrakcyjności instrumentów bezgotówkowych. Jest to związane z postępem technologicznym, skutkującym skróceniem czasu realizacji transakcji, zwiększeniem wygody korzystania oraz podniesieniem poziomu bezpieczeństwa (por. Auer et al., 2022; Harasim, 2016; Harasim & Klimontowicz, 2020; Polasik et al., 2013; Schuh & Stavins, 2016). Na zmniejszenie wykorzystania pieniądza gotówkowego wpływa również rozwój sieci akceptacji instrumentów bezgotówkowych, przede wszystkim popularyzacja terminali płatniczych, co skutkuje wzrostem użyteczności płatności bezgotówkowych dla klienta w wyniku oddziaływania tzw. efektów sieciowych (Bounie et al., 2016; Gowrisankaran & Stavins, 2004; Rochet & Tirole, 2002).

Pandemia COVID-19 przyspieszyła oba procesy składające się na „paradoks gotówki". Podczas jej trwania wzrósł popyt na pieniądz gotówkowy w wielu krajach (Chen et al., 2020; Guttmann et al., 2021; Pietrucha & Gulewicz, 2022; Rösl & Seitz, 2021), podczas gdy wykorzystanie gotówki do celów transakcyjnych spadło (Akana, 2021; Ardizzi et al., 2020; Cubides & O'Brien, 2022; Iwańczuk-Kaliska et al., 2023; Jonker et al., 2022; Kraenzlin et al., 2020). Co istotne, wspomniany paradoks pogłębił fakt, że we wczesnych etapach pandemii COVID-19 pojawiły się wątpliwości dotyczące możliwości przenosze-

nia wirusa poprzez gotówkę. Wątpliwości te manifestowały się poprzez: (i) wypowiedź rzecznika prasowego Światowej Organizacji Zdrowia (WHO), który sugerował ograniczenie wykorzystania gotówki, (ii) wyszukiwanie informacji na ten temat w sieci Internet, (iii) działania niektórych banków centralnych, które poddawały gotówkę kwarantannie oraz (iv) zdarzenia palenia gotówki w niektórych chińskich prowincjach (Auer et al., 2020; King & Shen, 2020; Yeung, 2020). Dopiero po około roku od rozpoczęcia pandemii wyniki badań laboratoryjnych wskazały, że ryzyko przeniesienia wirusa SARS-CoV-2 za pomocą gotówki jest bardzo niskie (Caswell et al., 2020; Tamele et al., 2021).

Warto zauważyć, że w przeszłości obserwowano już gwałtowny wzrost popytu na pieniądz gotówkowy, np. przed rokiem 2000 w związku z tzw. pluskwą milenijną[1] czy w roku 2008 po upadku banku Lehman Brothers (Rösl & Seitz, 2021, 2022). Jednak sytuacja odwrotna, gdzie następuje wzrost wykorzystania instrumentów bezgotówkowych, jak miało to miejsce podczas pandemii COVID-19, była bezprecedensowa. Należy bowiem wskazać, że wszelkie dotychczasowe zmiany w zachowaniach płatniczych miały przeważnie powolny charakter, zaś ewentualne szoki w tym zakresie zdarzały się, lecz działały w odwrotnym kierunku (tj. zwiększały wykorzystanie gotówki) i były krótkotrwałe. Wynikały zazwyczaj z ogólnokrajowych awarii elektronicznych systemów płatności bezgotówkowych (Khiaonarong et al., 2022; Togoh & Topping, 2018).

Na wykresie 1 przedstawiono dane ilustrujące zjawisko narastających rozbieżności między zmianami w zakresie popytu na pieniądz gotówkowy a wykorzystaniem gotówki do realizacji transakcji płatniczych. Prezentowane na wykresie dane dotyczącą wartości gotówki w obiegu (w relacji do PKB) oraz udziału transakcji gotówkowych w ogólnej liczbie transakcji detalicznych dla dziesięciu wybranych obszarów gospodarczych, które posiadają własne waluty, a jednocześnie prowadziły badania na temat zachowań płatniczych swoich mieszkańców[2]. Spośród tych krajów w okresie od 2001 do 2023 r. relacja gotówki w obiegu do PKB spadła jedynie w trzech krajach: Danii, Norwegii oraz Szwecji. Wszystkie te kraje charakteryzują się bardzo wysokim udziałem transakcji bezgotówkowych w realizacji transakcji detalicznych, a także wysokim zaufaniem społecznym oraz relatywnie niewielką skalą gospodarki nieformalnej (Kelmanson et al., 2019; Peiró-Palomino et al., 2024). W pozostałych krajach wskaźnik popytu na pieniądz gotówkowy wzrósł bądź utrzymał stabilny poziom. Należy przy tym zauważyć, że pomiędzy rokiem 2019 a 2020 (tj. w pierwszym roku trwania pandemii COVID-19) jedynie w Szwecji nie doszło do wzrostu popytu na pieniądz gotówkowy w relacji do PKB. Z kolei wykorzystanie gotówki do celów transakcyjnych sukcesywnie spada od początku prowadzenia badań zachowań

[1] Nazywaną również „problemem roku 2000", tj. strachem, że wraz z nastaniem roku 2000 część oprogramowania komputerowego przestanie funkcjonować poprawnie z uwagi na problem ze sposobem zapisu daty. Miało to z kolei spowodować kłopoty z dalszym funkcjonowaniem gospodarki, m.in. w związku z potencjalnym zamknięciem elektrowni, stacji uzdatniania wody itd.

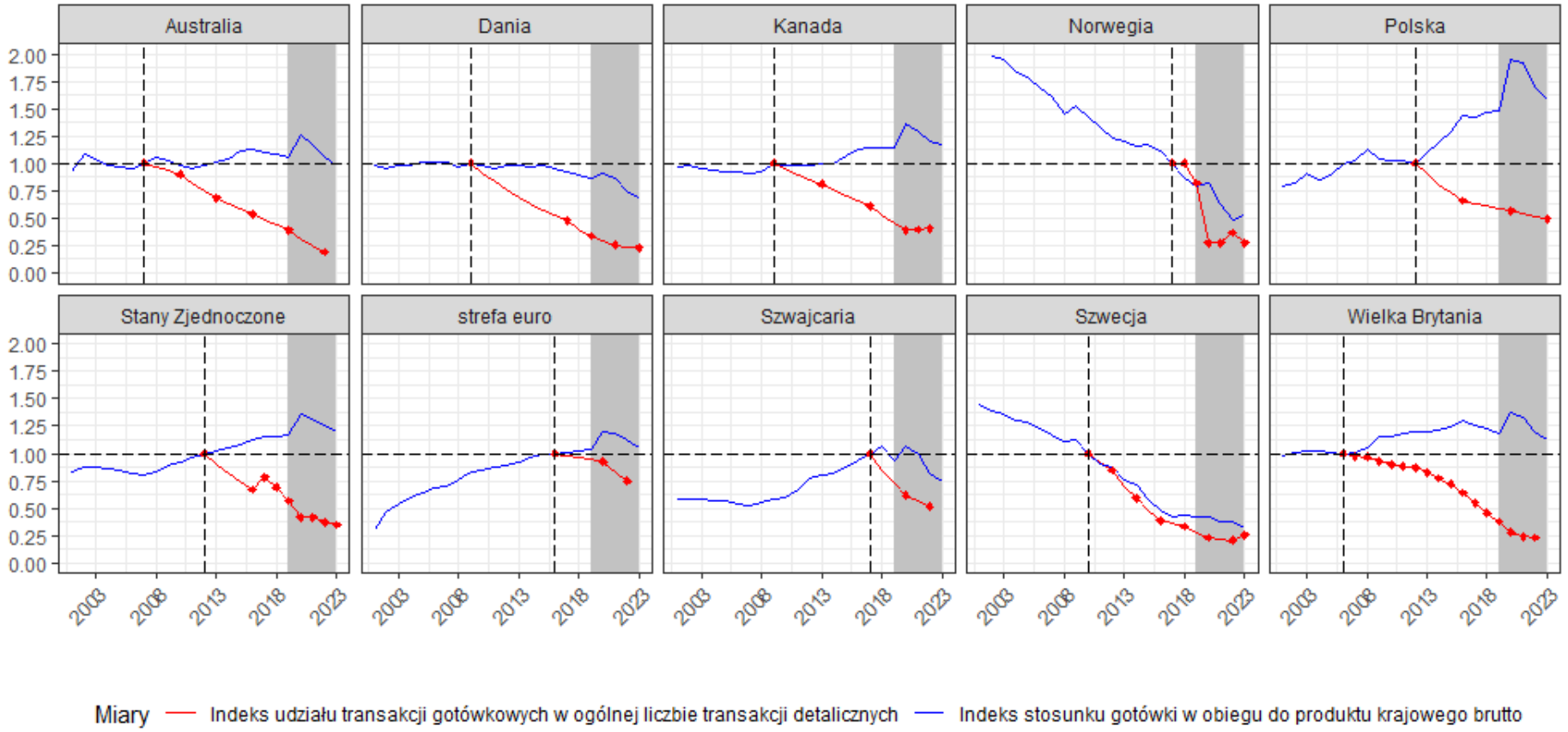
[2] Australia, Dania, Kanada, Norwegia, Polska, Stany Zjednoczone Ameryki, strefa euro, Szwajcaria, Szwecja i Wielka Brytania.

płatniczych we wszystkich analizowanych krajach.

W tym kontekście zidentyfikowane zostały luki badawcze, na wypełnieniu których koncentruje się niniejsza rozprawa. Podstawową luką był brak dogłębnych badań dotyczących wpływu pandemii COVID-19 na zmiany w zachowaniach płatniczych oraz w popycie na pieniądz gotówkowy. Badania prowadzone przed wybuchem pandemii COVID-19 nie były w stanie w pełni wyjaśnić, dlaczego w okresie jej trwania doszło do nasilenia się zjawisk składających się na „paradoks gotówki". Dodatkowo analiza potencjalnego wpływu obaw związanych z możliwością zarażenia się wirusem na wybór instrumentów płatniczych praktycznie nie istniała. Powstała zatem potrzeba zrozumienia, jak strach przed zarażeniem i inne obawy wynikające z kryzysu wpływają na decyzje płatnicze konsumentów oraz na popyt na pieniądz gotówkowy. Równie zatem istotnym zagadnieniem był brak międzynarodowych porównań zmian w zachowaniach płatniczych. Różnorodne reakcje władz poszczególnych państw, mające na celu ograniczenie efektów pandemii, jak również rozbieżności w charakterystyce danych krajów (m.in. w kontekście cech kultury narodowej czy stopnia nasycenia sieci akceptacji instrumentów bezgotówkowych) dały przestrzeń na prowadzenie tego typu analiz.

Dalsza struktura autoreferatu jest następująca. W części 1.2. omówiono postawione w rozprawie cele oraz sformułowane hipotezy badawcze. W części 1.3. przedstawiono strukturę samej rozprawy, tj. zbioru pięciu opublikowanych i powiązanych tematycznie artykułów naukowych. W części 1.4. omówiono dane i metody badawcze wykorzystane w poszczególnych pracach składających się na rozprawę. Z kolei w części 1.5. przedstawiono najważniejsze wyniki uzyskane w poszczególnych artykułach naukowych. W części 1.6. zaprezentowano wnioski ze zrealizowanych badań, jak również omówiono uzyskany wkład do dyscypliny naukowej. Część 1.7. zawiera podsumowanie rozprawy, zaś część 1.8. wykaz literatury cytowanej w autoreferacie.

Wykres 1. Zmiany udziału transakcji gotówkowych w ogólnej liczbie transakcji detalicznych i zmiany wartości gotówki w obiegu w relacji do PKB w okresie 2001–2023 w wybranych obszarach monetarnych



Notatka: Opracowanie własne. Dane dotyczące stosunku gotówki w obiegu do PKB opracowane zostały na podstawie danych Międzynarodowego Funduszu Walutowego oraz banków centralnych poszczególnych krajów. Dane o zachowaniach płatniczych pochodzą z badań empirycznych realizowanych w poszczególnych krajach. Rok przeprowadzenia pierwszego badania zachowań płatniczych w każdym kraju stanowi podstawę indeksu obu miar dla tego kraju równą 1. Linie niebieskie przedstawiają indeks wartości gotówki w obiegu w relacji do PKB na koniec danego roku. Czerwone punkty oznaczają zmianę indeksu udziału transakcji gotówkowych w ogólnej liczbie transakcji detalicznych w roku przeprowadzenia badania, a czerwone linie prezentują estymowaną przez autora zmianę zachowań w okresach pomiędzy badanami. Kolorem szarym zaznaczono okres trwania pandemii COVID-19.

1.2. Cel pracy i hipotezy badawcze

Mając na uwadze zidentyfikowane luki badawcze, w rozprawie postawiono następujący cel główny: Poznanie czynników wpływających na popyt na pieniądz gotówkowy oraz na zmianę zachowań płatniczych w trakcie pandemii COVID-19.

W rozprawie postawiono następujące cele szczegółowe:

— Przedstawienie zmienności popytu na pieniądz gotówkowy oraz wykorzystania instrumentów bezgotówkowych w trakcie trwania pandemii COVID-19.
— Poznanie wpływu pandemii na wykorzystanie gotówki oraz instrumentów bezgotówkowych, ze szczególnym uwzględnieniem: (i) indywidualnych obaw przed zarażeniem wirusem SARS-CoV-2 poprzez kontakt z instrumentami płatniczymi; (ii) obiektywnej skali zagrożenia oraz (iii) administracyjnych ograniczeń i tzw. *lockdownów*.
— Określenie skali i znaczenia zjawiska odmowy akceptacji gotówki przez przedsiębiorców.
— Wyjaśnienie wpływu indywidualnych cech konsumentów na zachowania płatnicze w warunkach pandemii COVID-19.
— Poznanie wpływu dotychczasowych zachowań płatniczych oraz zmiany w zachowaniach konsumenckich na zachowania płatnicze w trakcie pandemii.
— Określenie czynników różnicujących zmiany wywołane przez pandemię w zakresie popytu na pieniądz gotówkowy oraz zachowania płatnicze pomiędzy krajami.

W rozprawie postawiono następujące hipotezy badawcze, które podlegały weryfikacji w ramach poszczególnych prac:

H1: Obawa o możliwość zarażenia wirusem SARS-CoV-2 podczas korzystania z gotówki zwiększyła wykorzystanie instrumentów bezgotówkowych w trakcie pandemii.

H2: Dla osób, które częściej korzystały z gotówki przed pandemią COVID-19, mniejsze było prawdopodobieństwo zmiany ich zachowań płatniczych w kierunku instrumentów bezgotówkowych.

H3: W krajach, których mieszkańcy są bardziej skłonni do unikania niepewności, wzrost popytu na pieniądz gotówkowy w trakcie pandemii COVID-19 był wyższy, niż w pozostałych krajach.

H4: Sytuacje odmowy akceptacji gotówki przez sprzedawców w trakcie pandemii COVID-19 istotnie wpływały na zmniejszenie wykorzystania tego instrumentu w zakupach konsumenckich w Polsce.

1.3. Struktura rozprawy — zbiór artykułów

Realizacja celu głównego i celów szczegółowych oraz weryfikacja hipotez zostały przeprowadzone przez autora w ramach zbioru pięciu powiązanych tematycznie artykułów naukowych (kolejność zgodna z chronologią przygotowywania prac), to jest:

P1: Wisniewski, T. P., Polasik, M., Kotkowski, R., & Moro, A. (2024[3]). Switching from cash to cashless payments during the COVID-19 pandemic and beyond. *International Journal of Central Banking*, *20*(3), 303–372.

P2: Kotkowski, R., & Polasik, M. (2021[4]). COVID-19 pandemic increases the divide between cash and cashless payment users in Europe. *Economics Letters*, *209*, 110139. DOI: 10.1016/j.econlet.2021.110139

P3: Kaźmierczak, A., Kotkowski, R., & Maciejewski, K. (2021). Pandemia COVID-19 a popyt na pieniądz gotówkowy i zmiany w zachowaniach płatniczych w Polsce w 2020 r. *Studia i Prace Kolegium Zarządzania i Finansów*, *182*, 59–76. DOI: 10.33119/SIP.2021.182.4

P4: Kotkowski, R. (2023[5]). National culture and the demand for physical money during the first year of the COVID-19 pandemic. *Finance Research Letters*, *51*, 103483. DOI: 10.1016/j.frl.2022.103483

P5: Kotkowski, R., & Manikowski, A. (2023). Cash usage in Poland in 2020: Insights into the role of the COVID-19 pandemic and spatial aspects. *Journal of Banking and Financial Economics*, *1*(19), 85–113 DOI: 10.7172/2353-6845.jbfe.2023.1.5

Artykuły składające się na zbiór umieszczone zostały w części 2. niniejszej rozprawy, z kolei oświadczenia współautorów artykułów, wskazujący indywidualny wkład doktoranta w poszczególne prace, przedstawione zostały w załączniku A.

1.4. Dane i metody badawcze

1.4.1. Dane

Badania zrealizowane w artykułach zostały prowadzone na szerokim spektrum danych pozyskanych z różnorodnych źródeł.

Analizy przeprowadzone w artykułach P1 oraz P2 zrealizowane zostały na podstawie danych zaczerpniętych z badania konsumenckiego przeprowadzonego na próbie 5504 osób,

[3] Artykuł został pierwotnie opublikowany w serii *NBP Working Papers* pod numerem 337 w roku 2021: Dostęp: https://static.nbp.pl/publikacje/materialy-i-studia/337_en.pdf

[4] Artykuł został pierwotnie opublikowany w serii *NBP Working Papers* pod numerem 339 w roku 2021: Dostęp: https://static.nbp.pl/publikacje/materialy-i-studia/339_en.pdf

[5] Artykuł został pierwotnie opublikowany w serii *NBP Working Papers* pod numerem 351 w roku 2021: Dostęp: https://static.nbp.pl/publikacje/materialy-i-studia/351_en.pdf

przeprowadzonego w 22 krajach europejskich[6] w okresie od lipca do sierpnia 2020 r., czyli w pierwszych miesiącach trwania pandemii COVID-19. Realizacja badania tak wcześnie dała unikatową możliwość obserwowana omawianego zjawiska, kiedy jeszcze brak było wiedzy na temat sposobu przenoszenia się wirusa SARS-CoV-2 oraz szczepionek. Badanie ankietowe zrealizowane zostało przez agencję badawczą Interactive Research Center Sp. z o.o. (IRCenter) na panelu „Dynata" przy użyciu metody CAWI (*Computer Assisted Web Interview*). Zostało ono przeprowadzone w ramach grantu badawczego, sfinansowanego ze środków Narodowego Centrum Nauki (grant 2017/26/E/HS4/00858), pod nazwą „Wpływ rozwoju FinTech oraz regulacji prawnych na innowacje na rynku usług płatniczych w Unii Europejskiej: strategie sektora finansowego i potrzeby konsumentów". Kierownikiem badania był dr hab. Michał Polasik, prof. UMK (promotor rozprawy), a doktorant pełnił rolę podwykonawcy.

Oprócz danych ankietowych w pracy P1 wykorzystano szereg zmiennych zaczerpniętych ze źródeł zewnętrznych, m.in.:

— dane nt. liczby zgonów w wyniku COVID-19 (Mathieu et al., 2020);
— dane nt. wielkości populacji krajów objętych badaniem (Bank Światowy);
— wskaźniki rygorystyczności odpowiedzi na COVID-19 (COVID-19 Stringency Index) (Hale et al., 2021);
— wskaźniki wielkości szarej strefy (Kelmanson et al., 2019);
— wskaźniki kultury narodowej (Hofstede et al., 2010);
— wskaźniki adopcji Internetu (Eurostat).

Na podstawie danych Europejskiego Bank Centralnego, Banku Rozrachunków Międzynarodowych oraz Norges Bank autor opracował również wskaźniki nasycenia terminalami płatniczymi, które również zostały wykorzystane w pracy P1.

Badanie zrealizowane w pracy P3 uwzględniało szereg danych makroekonomicznych dotyczących gospodarki Polski. W artykule wykorzystano dane Narodowego Banku Polskiego oraz Głównego Urzędu Statystycznego (w zakresie omawiania zjawisk w Polsce) oraz dane Międzynarodowego Funduszu Walutowego uzupełnione o dane krajowych banków centralnych w przypadku realizacji porównań międzynarodowych. Korzystano z danych nt.:

— wartości pieniądza gotówkowego w obiegu w Polsce oraz wybranych[7] obszarach monetarnych;
— wartości transakcji bezgotówkowych dokonanych instrumentami bezgotówkowymi w Polsce;

[6] Austria, Belgia, Bułgaria, Czechy, Dania, Finlandia, Francja, Grecja, Hiszpania, Holandia, Irlandia, Litwa, Niemcy, Norwegia, Polska, Portugalia, Rumunia, Słowacja, Szwecja, Węgry, Wielka Brytania i Włochy.

[7] Bułgaria, Chorwacja, Czechy, Dania, Rumunia, Stany Zjednoczone Ameryki, strefa euro, Szwajcaria, Szwecja, Węgry i Wielka Brytania.

— tempa rotacji banknotów i monet w Polsce;
— tempa zmian wartości odprowadzeń i pobrań gotówki do i z Narodowego Banku Polskiego;
— spożycia gospodarstw domowych w Polsce.

W celu realizacji artykułu P4 doktorant przeprowadził kwerendę obejmującą zebranie miesięcznych danych dla 198 krajów świata, przy czym ostatecznie pełne dane panelowe dla wszystkich zmiennych wymaganych do oszacowania modelu zebrano dla 58 krajów. W artykule wykorzystano dane dotyczące:

— wartości pieniądza gotówkowego w obiegu na podstawie danych Międzynarodowego Funduszu Walutowego;
— produktu krajowego brutto (PKB) na podstawie danych Międzynarodowego Funduszu Walutowego oraz krajowych urzędów statystycznych;
— stóp procentowych na podstawie danych Banku Rozrachunków Międzynarodowych, Międzynarodowego Funduszu Walutowego oraz krajowych urzędów statystycznych;
— wskaźników cen towarów i usług konsumpcyjnych (CPI) na podstawie danych Banku Rozrachunków Międzynarodowych, Międzynarodowego Funduszu Walutowego oraz krajowych urzędów statystycznych;
— wskaźników rygorystyczności odpowiedzi na COVID-19 (COVID-19 Stringency Index) (Hale et al., 2021);
— wskaźników kultury narodowej (Hofstede et al., 2010).

Wszystkie zebrane i wykorzystane w pracy dane (wraz z kodem replikującym obliczenia) zostały opublikowane w otwartym repozytorium równolegle z publikacją artykułu. Dane dostępne są pod adresem: https://data.mendeley.com/datasets/hngpw44b8z/.

Artykuł P5 opracowany został na podstawie danych indywidualnych zaczerpniętych z badania pn. „Zwyczaje płatnicze w Polsce w 2020 r." zleconego oraz zrealizowanego przez Narodowy Bank Polski. Badanie zostało przeprowadzone w okresie od 15 września do 15 października 2020 r. na reprezentatywnej grupie 1265 respondentów w wieku od 15 lat i składało się z dwóch elementów: kwestionariusza ankiety oraz trzydniowego dzienniczka płatności. Badanie ankietowe zrealizowane zostało przy wykorzystaniu metody CAWI, zaś badanie dzienniczkowe przy pomocy metody PAPI (*Paper Assisted Personal Interview*). Pozyskanie danych od respondentów przeprowadziło konsorcjum firm badawczych PBS Sp. z o.o. oraz BR Sp. z o.o. W ramach wspomnianego badania doktorant, jako pracownik Narodowego Banku Polskiego, był odpowiedzialny za opracowanie narzędzi badawczych (tj. kwestionariusza ankiety i dzienniczka płatności), a także nadzorowanie realizacji badania. Ponadto pełnił rolę redaktora oraz głównego autora raportów przedstawiających wyniki badania (Kotkowski et al., 2021).

1.4.2. Metody badawcze

Badanie zrealizowane w artykule P1 koncentruje się na analizie dwóch zmiennych zależnych. Pierwsza odnosi się do deklarowanych zmian w zakresie wykorzystania płatności bezgotówkowych wskutek pandemii COVID-19, a druga do deklarowanych intencji ich dalszego używania. Do oszacowania prawdopodobieństwa zwiększenia częstości stosowania płatności bezgotówkowych wykorzystano klasyczne regresje logistyczne (*logistic regressions*) (Cox, 1958), biorąc pod uwagę cechy osobiste, warunki krajowe oraz zmiany zachowań konsumenckich wywołane przez pandemię. Do obliczeń macierzy wariancji-kowariancji zastosowano estymator odporny (White, 1980) oraz przeprowadzono analizę czynnikową w celu uniknięcia współliniowości.

W artykule P2 do oszacowania zależności między zmienną zależną a zmiennymi objaśniającymi wykorzystano regresje logistyczne o rozkładzie uporządkowanym (*ordered logistic regressions*) (McCullagh, 1980). Badanie oparto na czterech modelach. W pierwszym modelu oszacowano parametry głównej zmiennej wyjaśniającej wraz z podstawowymi socjodemograficznymi zmiennymi kontrolnymi. Drugi model rozszerzał pierwszy o zmienne kontrolne związane z innowacjami bankowymi i płatniczymi oraz użytkowaniem mediów społecznościowych. W trzecim modelu dodano binarne zmienne krajowe, zaś czwarty model uwzględnia interakcje między zmiennymi.

Analiza dokonana w artykule P3 realizowana była na podstawie wizualizacji danych źródłowych, które dotyczyły takich zjawisk jak wielkość podaży pieniądza gotówkowego w różnych obszarach monetarnych czy tempo rotacji banknotów. Część dotycząca płatniczego wykorzystania gotówki realizowana była z kolei poprzez wykorzystanie uznanych metod szacowania wielkości obiegu gotówkowego, tj. (i) klasycznego szacowania konsumpcji rezydualnej, (ii) udziału wypłat gotówkowych w wydatkach gospodarstw domowych, (iii) udziału wypłat gotówkowych w ogólnej wartości wypłat gotówkowych i transakcji płatniczych realizowanych bliskimi substytutami gotówki (Humphrey et al., 2000, 2004; Snellman et al., 2001), które przed przeprowadzeniem badania nie były zastosowane dla Polski.

W pracy P4, z uwagi na efekty stałe, wynikające z charakteru głównych zmiennych objaśniających, tj. wskaźników kultury narodowej, zamiast modelu panelowego zastosowano 12 regresji oszacowanych klasyczną metodą najmniejszych kwadratów (*ordinary least squares regression*) modelujących popyt na pieniądz gotówkowy przez kolejne 12 miesięcy, począwszy od wybuchu pandemii COVID-19. W kontekście faktu, iż dane wykorzystywane w modelu musiały mieć charakter miesięczny, dane pozyskiwane w ujęciu kwartalnym (jak np. PKB) były poddane procedurze dezagregacji bez zastosowania zewnętrznych wskaźników, przy użyciu metody opracowanej przez Dentona (1971) i dalej rozwiniętej przez Cholette'a (Cholette, 1984; Dagum & Cholette, 2006).

Z kolei w pracy P5 wykorzystano dwuetapowe podejście Heckmana (1976, 1979). Me-

toda ta stanowi podstawę obliczenia dwóch zestawów modeli: modeli adopcji i modeli użytkowania. Modele adopcji wykorzystują modele probitowe (Bliss, 1934) do oceny prawdopodobieństwa adopcji kart płatniczych, z kolei modele użytkowania wykorzystują klasycznej metody najmniejszych kwadratów.

1.5. Wyniki przeprowadzonych badań

Wyniki przedstawione w publikacjach stanowiących zbiór powiązanych tematycznie artykułów naukowych posłużyły do zrealizowania celów badawczych postawionych w rozprawie. Tabela 1 zawiera zestawienie celów realizowanych w poszczególnych pracach.

Tabela 1. Realizacja celów rozprawy w poszczególnych pracach

Cele rozprawy \ **Prace**		**P1**	**P2**	**P3**	**P4**	**P5**
Cel główny	Poznanie czynników wpływających na popyt na pieniądz gotówkowy oraz na zmianę zachowań płatniczych w trakcie pandemii COVID-19.	X	X	X	X	X
Cele szczegółowe	Przedstawienie zmienności popytu na pieniądz gotówkowy oraz wykorzystania instrumentów bezgotówkowych w trakcie trwania pandemii COVID-19.		X	X	X	X
	Poznanie wpływu pandemii na wykorzystanie gotówki oraz instrumentów bezgotówkowych, ze szczególnym uwzględnieniem: (i) indywidualnych obaw przed zarażeniem wirusem SARS-CoV-2 poprzez kontakt z instrumentami płatniczymi; (ii) obiektywnej skali zagrożenia oraz (iii) administracyjnych ograniczeń i tzw. *lock-downów*.	X	X		X	
	Określenie skali i znaczenia zjawiska odmowy akceptacji gotówki przez przedsiębiorców.					X
	Wyjaśnienie wpływu indywidualnych cech konsumentów na zachowania płatnicze w warunkach pandemii COVID-19.	X	X			X
	Poznanie wpływu dotychczasowych zachowań płatniczych oraz zmiany w zachowaniach konsumenckich na zachowania płatnicze w trakcie pandemii.	X	X			X
	Określenie czynników różnicujących zmiany wywołane przez pandemię w zakresie popytu na pieniądz gotówkowy oraz zachowania płatnicze pomiędzy krajami.		X		X	

W artykule P1 zbadano wpływ wybuchu pandemii COVID-19 na wybory konsumentów dotyczące metod płatności w punktach sprzedaży. Uzyskane wyniki wskazały, że osoby postrzegające korzystanie z gotówki jako zwiększające ryzyko transmisji wirusa częściej wybierały bezgotówkowe alternatywy. Zachowania płatnicze ulegały również pośrednim zmianom pod wpływem pandemii, która oddziaływała na wzorce codziennych aktywności konsumenckich. W szczególności w przestrzeniach fizycznych zmienione nawyki wywarły znaczący wpływ, skłaniając jednostki do wyboru transakcji bezgotówkowych. Zmniejszenie wykorzystania gotówki można również przypisać zmianom w zachowaniach konsumenckich *online*. Co istotne, obawa przed zakażeniem przez gotówkę oraz zmienione nawyki nie tylko wpływały na bieżące wybory między instrumentami płatniczymi, ale także oddziaływały na deklarowane przyszłe intencje odchodzenia od gotówki po zakończeniu pandemii.

W artykule P2 przeanalizowano, jak przeszłe zachowania płatnicze wpłynęły na zmianę tych zachowań w trakcie pandemii COVID-19. Wyniki badania wskazują, że konsumenci, którzy przed wybuchem pandemii częściej dokonywali płatności bezgotówkowych, po jej rozpoczęciu jeszcze zwiększyli wykorzystanie tych instrumentów. Z kolei konsumenci, którzy przed pandemią płacili głównie gotówką, często kontynuowali tę praktykę. W rezultacie rozdźwięk między osobami płacącymi gotówką a tymi, którzy tego nie robią, poszerzył się podczas pandemii. Dodatkowo zaobserwowano, że prawdopodobieństwo częstszego korzystania z płatności bezgotówkowych różniło się znacząco pomiędzy krajami, co z kolei wskazuje na istotną rolę czynników specyficznych dla poszczególnych państw.

W artykule P3 omówiono fenomen wzrostu zapotrzebowania na pieniądz gotówkowy w kontekście pandemii COVID-19 w Polsce. Wyniki badania wskazują, że wzrost popytu na pieniądz gotówkowy w Polsce w trakcie pandemii COVID-19 nie był spowodowany motywem transakcyjnym, lecz motywem tezauryzacyjnym. Świadczy o tym fakt, że wykorzystanie gotówki do celów transakcyjnych w Polsce w 2020 r. spadło dwukrotnie szybciej, niż wskazywały na to trendy sprzed pandemii, zaś wzrost ogólnego zapotrzebowania na gotówkę był najwyższy w Europie.

W artykule P4 zbadano, czy cechy kultury narodowej, a w szczególności unikanie niepewności, wpłynęło na popyt na pieniądz gotówkowy w trakcie pierwszego roku trwania pandemii COVID-19. Wyniki badania wskazują, że wskaźnik unikania niepewności (UAI) oraz wskaźnik pobłażliwości (IVR), w ujęciu makroekonomicznym, miały istotny statystycznie wpływ na zapotrzebowanie na gotówkę podczas pandemii. Co więcej, zaobserwowano, że w krajach, w których skala administracyjnych ograniczeń i *lockdownów* była większa, popyt na pieniądz gotówkowy rósł istotnie statystycznie.

Z kolei w artykule P5 podjęto próbę wyjaśnienia, dlaczego i w jakich okolicznościach polscy konsumenci używają gotówki do płacenia za towary i usługi oraz czy pandemia COVID-19 miała na nie wpływ. Podstawowe wyniki dotyczące czynników socjodemograficznych są spójne z rezultatami innych tego typu badań. Wskazują, że cechy kon-

sumentów, takie jak zaawansowany wiek, niższe dochody i niższy poziom wykształcenia są związane z płatnościami gotówkowymi. Istotne znaczenie ma również postrzeganie poszczególnych instrumentów płatniczych pod względem ich szybkości i bezpieczeństwa. Zaobserwowano również, że włączenie do analizy zmiennych dotyczących samooceny zmian w zachowaniach płatniczych podczas pandemii COVID-19 dało spójne wyniki. Oznacza to, że osoby deklarujące większe wykorzystanie płatności bezgotówkowych podczas pandemii faktycznie istotnie statystycznie częściej korzystały z tych instrumentów w porównaniu z osobami, które nie zgłaszały takich zmian. Co więcej, zaobserwowano, że obawy przed przenoszeniem wirusa SARS-CoV-2 przez banknoty i monety, manifestujące się odmową przyjmowania gotówki przez niektórych sprzedawców, miały istotny wpływ na wybór przez konsumentów metod płatności w punktach sprzedaży — doświadczenia te znacząco zmniejszyły używanie gotówki w kolejnych transakcjach. Zwrócono również uwagę, że wysoki poziom adopcji kart zbliżeniowych w Polsce znacząco ogranicza korzystanie z gotówki. Badania uwzględniły również aspekt przestrzenny, pokazując znaczną różnorodność zachowań płatniczych w poszczególnych regionach Polski. Odkryto między innymi, że im więcej czasu potrzebna na dotarcie do bankomatu, tym rzadziej konsumenci używają gotówki, co potwierdza zjawisko „spalania gotówki" (Alvarez & Lippi, 2017) — gotówka jest częściej używana, gdy jest „pod ręką", zaś konsumenci mają jej więcej w swoich portfelach, gdy są dalej od punktów wypłaty.

1.6. Wnioski ze zrealizowanych badań i wkład do dyscypliny naukowej

Wyniki zrealizowanych badań, prezentowanych w poszczególnych pracach składających się na rozprawę, rozszerzyły stan wiedzy na temat czynników wpływających na zmianę popytu na pieniądz gotówkowy oraz zmianę zachowań płatniczych w trakcie pandemii COVID-19. Pozwoliły także na weryfikację postawionych w rozprawie hipotez badawczych.

W oparciu o wyniki przedstawione w artykule P1 zweryfikowano pozytywnie hipotezę H1. Obawa o możliwość zarażenia wirusem SARS-CoV-2 podczas korzystania z gotówki zwiększyła wykorzystanie instrumentów bezgotówkowych w trakcie pandemii. Według wiedzy doktoranta, badanie P1 jest jedną z pierwszych prac empirycznych o skali międzynarodowej na ten temat[8], potwierdzoną również później w literaturze (por. Huterska et al., 2021; Yu & Chen, 2022). Potwierdzenie tej hipotezy wskazuje na potrzebę zintensyfikowania badań dotyczących ryzyka przenoszenia chorób poprzez monety i banknoty celem

[8] Wyniki badań zawarte w pracy P1 prezentowane były m.in. podczas *5. International Cash Conference 2021*, zorganizowanej przez Deutsche Bundesbank (niemiecki bank centralny) w dniach 15-16 czerwca 2021, oraz *10. Economics of Payments*, zorganizowanej przez Suomen Pankki (fiński bank centralny) w dniach 20-22 października 2021.

uniknięcia podobnych nagłych reakcji w przyszłości. Istotne jest również, aby wiedza na ten temat była lepiej rozpowszechniona wśród ogółu populacji.

W oparciu o wyniki zawarte w pracy P2 zweryfikowano pozytywnie hipotezę H2. Wśród osób, które częściej korzystały z gotówki przed pandemią COVID-19, mniejsze było prawdopodobieństwo zmiany ich zachowań płatniczych w kierunku instrumentów bezgotówkowych. Należy jednak podkreślić, że krzywa reakcji konsumentów różniła się pomiędzy krajami. Wnioski z tych obserwacji są następujące: po pierwsze, wskazują na problemy z włączeniem finansowym oraz trudności osób wykluczonych do szybkiej adaptacji do nowych warunków; po drugie, fakt, że zmiany zachowań płatniczych w odpowiedzi na pandemię różną się w zależności od kraju, sugeruje znaczącą rolę czynników dla nich specyficznych. Do takich czynników zaliczyć można ogólny poziom adopcji metod bezgotówkowych, różnice w rozwoju infrastruktury płatniczej, wielkość szarej strefy czy różnice kulturowe.

Wyniki zaprezentowane w pracy P4 pozwoliły na pozytywnie zweryfikowanie hipotezy H3. Społeczeństwa bardziej skłonne do unikania niepewności charakteryzowały się większym wzrostem popytu na pieniądz gotówkowy w trakcie pandemii COVID-19. Obserwacja ta ma istotne implikacje praktyczne dla banków centralnych, gdyż sugeruje ona, że w krajach charakteryzujących się większym unikaniem niepewności banki centralne powinny posiadać zwiększone zasoby pieniądza gotówkowego na wypadek konieczności zaspokojenia dodatkowego popytu. Podczas pisania artykułu P4 rosyjska inwazja na Ukrainę, która rozpoczęła się w lutym 2022 roku, znacząco zwiększyła popyt na gotówkę w sąsiadujących z Ukrainą krajach spoza strefy euro (Białoruś, Węgry, Mołdawia, Polska i Rumunia). Wszystkie te kraje charakteryzują się średnią wartością wskaźnika unikania niepewności na poziomie 91 punktów. W kwietniu 2022 roku wartość gotówki w obiegu w tych krajach była średnio o 7,9% wyższa niż w styczniu 2022 roku (miesiącu poprzedzającym inwazję). Z kolei dla krajów strefy euro, o przeciętnie niższych wskaźnikach unikania niepewności, wzrost wartości gotówki wyniósł w tym samym okresie łącznie tylko 3,1%.

Wyniki przedstawione w artykule P5 umożliwiły na pozytywną weryfikację hipotezy H4. Wykazano, że odmowa akceptacji gotówki przez sprzedawców podczas pandemii COVID-19 znacząco wpłynęła na zmniejszenie jej wykorzystania przez konsumentów. Ta obserwacja ma istotne znaczenie zarówno naukowe, jak i praktyczne. Potwierdza ona bowiem zasadność zmian wprowadzonych w ustawie o usługach płatniczych[9], która nałożyła na sprzedawców obowiązek przyjmowania płatności gotówką. Inicjatorem tych zmian był Prezes Narodowego Banku Polskiego, który zwrócił się do Prezydenta RP o wsparcie w uregulowaniu tego obszaru[10], m.in. po analizie wyników badania pn. „Zwyczaje płatnicze w Polsce w 2020 r." (Kotkowski et al., 2021). Dane empiryczne uzyskane w

[9] *Ustawa z dnia 17 września 2021 r. o zmianie ustawy o usługach płatniczych* (Dz.U. 2021 poz. 1814).

[10] Druk sejmowy nr 1221. Przedstawiony przez Prezydenta Rzeczypospolitej Polskiej projekt ustawy o zmianie ustawy o usługach płatniczych. Dostęp: https://www.sejm.gov.pl/Sejm9.nsf/druk.xsp?nr=1221

ramach wspomnianego badania wykorzystano w artykule P5. Badanie pn. „Zwyczaje płatnicze w Polsce w 2020 r." wykazało, że około 8% respondentów doświadczyło odmowy przyjęcia płatności gotówkowej, mimo że zgodnie z art. 32 ustawy o Narodowym Banku Polskim[11] „znaki pieniężne emitowane przez NBP są prawnymi środkami płatniczymi na obszarze Rzeczypospolitej Polskiej". Sprzedawcy akceptujący instrumenty bezgotówkowe mieli wcześniej swobodę w decyzji o przyjmowaniu gotówki, jednak ostatecznie w kontekście problemów z pełnym włączeniem finansowym wszystkich konsumentów w Polsce, uznano to za sprzeczne z zasadami współżycia społecznego.

1.7. Podsumowanie

Wybuch pandemii COVID-19 doprowadził do drastycznych zmian w wielu obszarach życia społecznego i gospodarczego na całym świecie. Badania przeprowadzone w ramach niniejszej rozprawy przyczyniły się do lepszego zrozumienia, jak pandemia wpłynęła na popyt na pieniądz gotówkowy oraz zachowania płatnicze konsumentów, dostarczając jednocześnie ważnych obserwacji i wniosków na temat źródła tych zmian. W trakcie pandemii COVID-19 zaobserwowano bowiem znaczący wzrost popytu na gotówkę przy jednoczesnym spadku jej wykorzystania do celów transakcyjnych. Zatem obserwowane od lat zjawisko nazywane „paradoksem gotówki" uległo pogłębieniu.

Wyniki badań wskazują, że głównymi czynnikami wpływającymi na zachowania płatnicze konsumentów były obawy przed zarażeniem wirusem SARS-CoV-2 oraz zmiany w codziennych nawykach. Konsumenci, którzy przed pandemią preferowali płatności bezgotówkowe, byli bardziej skłonni kontynuować tę praktykę, a nawet zwiększyć częstotliwość korzystania z takich instrumentów. Z kolei osoby, które wcześniej korzystały głównie z gotówki, rzadziej zmieniały swoje nawyki na rzecz bezgotówkowych form płatności. Sytuacja ta prowadzi do narastania rozwarstwienia społecznego w zakresie wykorzystania instrumentów płatniczych. Ważnym odkryciem była obserwacja, że czynniki ogólnokrajowe mają istotny wpływ na możliwość dostosowywania się mieszkańców poszczególnych krajów do bodźca zewnętrznego, jakim w tym przypadku była pandemia.

Na przykładzie Polski zaobserwowano również, że wzrost popytu na pieniądz w trakcie pandemii COVID-19 nie był spowodowany motywem transakcyjnym, lecz motywem tezauryzacyjnym. Świadczy o tym fakt, że wykorzystanie gotówki do celów transakcyjnych w Polsce w 2020 r. spadło w tempie dwukrotnie szybszym, niż wskazywały na to trendy sprzed pandemii. W tym samym czasie wzrost ogólnego zapotrzebowania na gotówkę w Polsce był najwyższy w Europie. Co więcej, w zakresie międzynarodowym udowodniono, że cecha kultury narodowej, jaką jest unikanie niepewności, była istotnym czynnikiem wpływającym na zwiększenie popytu na pieniądz gotówkowy w trakcie pierwszego roku pandemii COVID-19. Wskazuje to, że w czasach niepewności konsumenci mają tenden-

[11] *Ustawa z dnia 29 sierpnia 1997 r. o Narodowym Banku Polskim* (Dz. U. z 2022 r. poz. 2025).

cję do gromadzenia gotówki jako bezpiecznego aktywa, nawet jeśli nie mają zamiaru jej wykorzystywać do realizacji celów transakcyjnych.

Istotnym odkryciem była również rola zjawiska odmowy akceptacji gotówki przez sprzedawców, która znacząco wpłynęła na zmniejszenie wykorzystania gotówki przez konsumentów w ich kolejnych transakcjach. W Polsce odpowiedzią na to wyzwanie było wprowadzenie zainicjowanych przez Narodowy Bank Polski regulacji prawnych, zobowiązujących sprzedawców do akceptacji płatności gotówkowych, co miało na celu zapewnienie utrzymania społecznej akceptacji gotówki jako środka płatniczego i przeciwdziałanie wykluczeniu finansowemu.

Wyniki badań zrealizowane w ramach rozprawy pozwoliły zgłębić ważne społecznie i gospodarczo zjawiska oraz wskazały kierunki dalszych badań i działań praktycznych, zarówno na poziomie międzynarodowym, jak i krajowym. Proponowane obszary badań obejmują: (i) weryfikację trwałości zmian w zachowaniach płatniczych spowodowanych przez pandemię COVID-19 po jej zakończeniu; (ii) dalsze studia nad epidemiologicznym bezpieczeństwem poszczególnych instrumentów płatniczych; (iii) analizę wpływu czynników krajowych (takich jak zróżnicowany poziom adopcji metod płatności, stopień rozwoju infrastruktury płatniczej czy rozmiary szarej strefy) na zmiany zachowań płatniczych konsumentów w poszczególnych krajach; (iv) badanie wpływu kultury narodowej na popyt na pieniądz gotówkowy w okresach wzmożonej niepewności oraz tempo zmian zachowań płatniczych.

Sugerowane działania praktyczne obejmują: (a) utrzymanie przez banki centralne większych zasobów pieniądza gotówkowego i zadbanie przez nie o niezawodność łańcuchów dostaw gotówki, w celu zaspokojenia ewentualnego wzmożonego popytu (np. w sytuacjach zagrożenia) i uniknięcia paniki bankowej; (b) lepszą komunikację dotyczącą epidemiologicznych zagrożeń związanych z obiegiem gotówkowym oraz (c) rozważenie przez rządy i instytucje publiczne poszczególnych krajów podjęcia działań, w tym legislacyjnych, mających na celu zapewnienie możliwości dokonywania transakcji gotówkowych.

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Część 2.

Zbiór artykułów

P1:
Switching from cash to cashless payments during the COVID-19 pandemic and beyond

Switching from Cash to Cashless Payments during the COVID-19 Pandemic and Beyond*

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Using a survey of 5,504 respondents from 22 European countries, we examine preferences regarding cash and cashless payments at the point of sale (POS) during the COVID-19 crisis. Consumers favor cashless transactions when they believe that handling cash presents a higher risk of infection. Moreover, the habits they develop during periods of restrictions and lockdowns appear to further diminish their appetite for transacting in cash. Not only do these factors affect current choice of payment method, but they also influence declared future intentions to move away from cash after the pandemic is over.

JEL Codes: E41, E42, I12, I18.

1. Introduction

The highly contagious coronavirus disease 2019 (COVID-19) was declared a pandemic on March 11 (World Health Organization 2020).

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Up to the end of December 2023, it infected officially more than 774 million people and claimed almost 7 million lives (Mathieu et al. 2020). The mental, social, and economic lives of virtually everyone around the globe were affected by this health risk, profoundly changing people's habits and behaviors. In an attempt to limit the spread of the virus, governments enforced rules pertaining to social distancing and the use of face masks, advocated self-isolation, handwashing, and other types of hygienic measures. Partially due to government-imposed lockdowns, a significant reduction in people's mobility and consumption was observed, with a substitution from in-store to online shopping becoming particularly prominent (Bounie, Camara, and Galbraith 2023).

At the same time, an unprecedented outpouring of speculation about the possible link between handling physical money and COVID-19 infections has emerged (Auer, Cornelli, and Frost 2020). Research regarding this phenomenon indicated that a significant fraction of the population reduced their transactional use of cash in response to the pandemic. In its IMPACT study, the European Central Bank (2020) showed that about 40 percent of respondents in the euro area curtailed their use of cash and 38 percent of them declared that the main stimulus for their changed payment behavior was the possibility of being infected through touching banknotes. Surveys conducted by the Federal Reserve System (Kim, Kumar, and O'Brien 2020), Bank of Canada (Chen et al. 2020), and National Bank of Poland (Kotkowski, Dulinicz, and Maciejewski 2022) reached similar conclusions, noting further that some risk-averse merchants ceased to accept cash as a means of payment. Using the Dutch payment diary data, Jonker et al. (2022) shed more light on demographic and transaction-specific drivers that influence the change in payment habits due to COVID-19. Notably, the effect of the pandemic on the transactional utility of cash is manifest not only in declarations of individual respondents but also in more aggregate statistics. The studies focusing on data from retail systems, national payment schemes, or particular banks in Canada, Switzerland, Italy, and France revealed a rapid increase in the adoption of cashless payments, despite a decline in the level of general consumption (see Ardizzi, Nobili, and Rocco 2020; Bounie, Camara, and Galbraith 2023; Dahlhaus and Welte 2021; Kraenzlin, Meyer, and Nellen 2020).

In this paper, we further probe the utility of cash during the COVID-19 crisis. Using a unique data set, we can model respondents' inclination to switch from cash to cashless instruments. The richness of our data source permits us to disentangle two critical pandemic-related factors that drive underlying behaviors. Firstly, there is the direct impact of an individual's perception of viral transmission risk associated with touching banknotes and coins. Secondly, and equally importantly, this global health emergency has changed habits related to shopping, human interaction, mobility, health regimens, and ways of working. Entrenchment of these habits could have an indirect but lasting influence on payment method preferences. Our factor analysis indicated that those shifts in behavioral patterns could be categorized by whether they occurred in the physical sphere or in the cyberspace. By controlling for a wide range of respondents' and country-level characteristics, we extricated these direct and indirect influences in a logistic regression setting. We document that both fear of contagion and altered habits played a prominent role in the decision to abandon cash for transactional purposes during the COVID pandemic. Analogous results are obtained when modeling the respondents' intention to use cashless instruments more frequently after the pandemic is over. Notably, changes in habits related to physical contact exerted a more statistically and economically powerful impact on payment preferences of respondents than the altered behaviors in the online environment.

Several aspects distinguish our work from existing studies. The analysis of cash usage by the European Central Bank (2020) performed during the pandemic period reports only aggregated figures, without attempting to link COVID-19 responses to the selection of payment method at an individual level. Although Jonker et al. (2022) overcame this shortcoming by explicating changes in the payment behavior of Dutch consumers, our analysis is on a much larger scale—we examine 22 European countries rather than 1. What is more, to the best of our knowledge, this is the first study empirically linking the magnitude of fear of viral contagion with the choice of payment instrument. Similarly, the fact that changes in other habits could have a domino-like effect on peoples' payment choices has hitherto not been considered in the literature. To add further depth to our inquiry, we not only consider historical preferences towards

cashless payments, but also interrogate individuals' declarations about their future payment intentions after the COVID-19 pandemic is over. Our empirical model controls for a wide range of factors, including perceptions of different payment instruments, experience of using them, stances on privacy, general technical literacy, a variety of sociodemographic factors, and country-level variables such as the number of COVID-related deaths and size of the shadow economy.

The remainder of the paper is organized as follows. Section 2 presents a literature review, which embodies two important themes. It starts by reviewing the evidence on SARS-CoV-2 survival on banknotes and coins, moving subsequently to a consideration of consumer payment behavior. Section 3 outlines our methodological approach, while Section 4 provides a description of the data set, definitions of variables, and a set of summary statistics. Our main empirical results and their interpretation are included in Section 5, and this is followed by a battery of robustness checks in Section 6. Section 7 presents reflections on the practical implications of our findings. The paper ends with concluding remarks.

2. Literature Review

2.1 Methods of Payments and Infectious Disease Transmission

Studies examining the spread of pathogens through the use of cash date back to the 1970s (see, for instance, Abrams 1972). In absence of disinfection, various types of microbes could adhere to the surface of currency, leading to the transmission of communicable diseases. A study by Vriesekoop et al. (2016) exploring bacterial survival concluded that microbial persistence is greater on paper banknotes than on polymer bills and coins. According to the estimates of Pope et al. (2002), about 94 percent of $1 bills are contaminated with pathogenic or potentially pathogenic bacteria. This statistic reaches 100 percent for currency notes in Ghana (Tagoe et al. 2009). Bills could also potentially harbor fungi and yeast (Basavarajappa, Rao, and Suresh 2005), parasites (Uneke and Ogbu 2007), and viruses (Maritz et al. 2017). The literature review conducted by Angelakis et al. (2014) concludes that banknotes

retrieved from hospitals may carry antibiotic-resistant MRSA, while those from food outlets may be tainted with salmonella and E. coli.

While the existence of the monetary microbiome is well documented in the medical literature, one may wonder to what extent this message reverberated through broader society prior to the COVID-19 crisis. The reaction to the study of Gedik, Voss, and Voss (2013) epitomizes the attitudes of the bygone era. Their insightful analysis examined bacterial survival on banknotes from different countries. For their work, the authors received a satirical Ig Nobel Prize for economics in 2019. One year later, the escalating death toll from coronavirus caused a sea change in general attitudes towards this problem.

Discovery of durability of SARS-CoV-2 on surfaces (Chin et al. 2020; van Doremalen et al. 2020) posed a question as to whether the virus could be transmitted via cash. Having put a droplet of the virus on a banknote, Chin et al. (2020) observed that the note remained infectious for a period of four days. Harbourt et al. (2020) investigated the persistence of SARS-CoV-2 on U.S. banknotes produced from a blend of linen and cotton. At a temperature of 4°C, the virus was detectable for 96 hours on $1 bills and for 72 hours on $20 notes. Surface stability however reduced with ambient temperature, with the virus being viable for eight hours at 22°C and for four hours at 37°C. A study commissioned by the Bank of England (Caswell et al. 2020) found that the virus maintained its stability on banknotes for one hour, with its presence being dramatically reduced to about 5 percent of its initial level over the subsequent five hours. Those are very low estimates compared to those of Riddell et al. (2020), who claim that the coronavirus causing COVID-19 is still detectable on polymer and paper notes 28 days following inoculation. With regard to coins, the time to complete virus decay may depend on the metal used to mint the coin. For instance, this duration appears to be 8 hours for copper and 48 hours for stainless steel (van Doremalen et al. 2020). At the time of writing, there are still many questions as to whether cash is indeed a fomite and what exactly is the severity of the risks involved. The general public was bombarded with mixed messages in this regard. For instance, the World Health Organization has recommended that people wash their hands after coming in contact

with notes and coins (Pal and Bhadada 2020). However, a recent study commissioned by the European Central Bank (ECB) showed that the risk of contracting the disease from contact with cash is very low and that cash is reasonably safe to use (Tamele et al. 2021).

The question arises as to whether the dangers posed by cash can be circumvented by switching to cashless payments. After all, SARS-CoV-2 can remain stable on plastic surfaces for seven days (Chin et al. 2020), which in itself could endanger users of payment card terminals and PIN (personal identification number) pads. However, limits on contactless payments were increased in many countries during the pandemic (Mastercard 2020), obviating the need to input a PIN code for most transactions at the point of sale. The vast majority of transactions conducted online or via mobile banking also do not require contact with potentially contaminated surfaces. Consequently, one may argue that changing one's payment habits may reduce the risk of infection.

The stance of money issuers vis-à-vis the problem of jeopardized public health proved to be somewhat confusing. Central banks differed markedly in terms of their response to information about the potential threat posed by cash. Some central banks (such as the ECB and those of the United Kingdom, Germany, Austria, Sweden, and South Africa) either stressed that the risk of SARS-CoV-2 transmission through cash is minimal compared to other frequently touched objects or refused to acknowledge the possibility of contagion altogether. But a few other nations took different approaches. For instance, central banks in the United States, China, South Korea, Kuwait, Hungary, and Poland started to quarantine and disinfect cash (Auer, Cornelli, and Frost 2020; King and Shen 2020). A regional branch of the People's Bank of China proceeded to destroy banknotes that had circulated in hospitals, wet markets, and on buses (Yeung 2020). The central banks of Georgia and India started to promote cashless payments, while, at the other end of the spectrum, monetary authorities in Canada, Portugal, and Poland appealed to retailers who stopped accepting cash to discontinue such practices. Their pleas were motivated by concerns over those who are financially excluded.

2.2 Consumer Payment Behavior

Consumer payment behavior has been a burgeoning field of research since the 1980s, starting with the seminal work of Boeschoten and Fase (1989). Nowadays, country-specific inquiries into this topic are primarily carried out by central banks. The U.S. Federal Reserve has been conducting an annual Survey of Consumer Payment Choice since 2008 (Foster, Greene, and Stavins 2020) and a Diary of Consumer Payment Choice since 2015 (Greene and Stavins 2020). In a similar vein, studies regarding Dutch payment behavior have been undertaken by De Nederlandsche Bank (DNB) since 2010 (see DNB 2020). A number of other countries, including Australia, Canada, Denmark, Sweden, Germany, Poland, and Norway, also endeavor to run similar surveys at regular intervals. Going beyond national level, the ECB performed its pan-euro-area study in 2016 (see Esselink and Hernández 2017) and 2019 (ECB 2020). Taken together, the evidence gathered reveals a pattern of steady decline in the share of retail transactions conducted using cash. In the United States this share fell from about 30 percent in 2009 to 21.5 percent in 2019 (Foster, Greene, and Stavins 2020). This downward-sloping trend is mirrored in the United Kingdom with a decline from about 80 percent in 1990 to 23 percent in 2019 (Caswell et al. 2020) and in the euro area, where the proportion of cash POS and P2P (peer-to-peer) payments decreased from 79 percent to 73 percent between 2016 and 2019 (ECB 2020).

Personal payment choice is an outcome of myriad variables, both intrinsic and extrinsic to a given individual. Internal aspects embrace perceptions of different payment instrument characteristics such as perceived speed of payment, security, ease of use, and budget control (Koulayev et al. 2016; Schuh and Stavins 2016), or stances on issues like privacy and trust (Png and Tan 2020). External influences could incorporate, for instance, socioeconomic and sociopsychological factors (Stavins 2001; van der Cruijsen and van der Horst 2019). It is worth noting that the characteristics of transactions could be also important in terms of influencing the outcome. Such characteristics encompass the transaction amount (Arango-Arango et al. 2018; Wang 2016), the possibility of paying in the way one desires (Bagnall et al. 2016; Bounie, François, and Van Hove 2017), steering mechanisms used by merchants (Arango, Hyunh, and Sabetti 2015; Stavins

and Shy 2015), rewards offered by issuers of cashless payments (Bolt, Jonker, and van Renselaar 2010; Simon, Smith, and West 2010), or costs associated with the transaction (Arango-Arango et al. 2018).

Prior to the COVID-19 outbreak, there was little research investigating the link between spread of contagious disease and change in people's payment behavior. Closest to this subject is the work by Galbraith and Tkacz (2013), who used payment systems data to examine the economic impact of extreme events, like the 9/11 terrorist attacks and the SARS epidemic of March–June 2003. However, at the time, the SARS epidemic did not alter behavior significantly enough to generate detectable effects. Following the escalation of COVID-19, more research on this topic started to emerge. Apart from our study, other papers that used individual-level data include the aforementioned work of Jonker et al. (2022) and that of Saroy et al. (2022) who documented a pandemic-induced shift towards cashless payments in India. The authors argued that awareness of digital payment methods, access to different instruments, and relief welfare transfers affected the shift. Another study by Cevik (2020) reported that the spread of contagious diseases like Ebola, SARS, malaria, or yellow fever decreased the demand for physical money in the affected areas and noted that this observation may have ramifications for the current situation.

Ours is a paper that focuses specifically on how the context of the COVID-19 pandemic affected intentions to use cash. In our exploration, we distinguish two important mechanisms through which such intentions could be affected. First, individuals may exhibit varying degrees of subjective fear attributable to dealing with currency that could potentially be virally contaminated. Such fears would be a direct stimulus steering consumers towards cashless transactions, insofar as cashless transactions are perceived as a lower contagion risk. Second, there could be an indirect effect arising from the fact that the pandemic has profoundly altered our ways of life. Bound by government restrictions and by the commonsensical avoidance of jeopardy, individuals showed a stronger preference for online shopping (Bounie, Camara, and Galbraith 2023; Watanabe and Omori 2020), reduced their mobility and consumption (Bounie, Camara, and Galbraith 2023; Carvalho et al. 2021; Mínguez, Urtasun, and de Mirasierra 2020), modified their working practices (Bick, Blandin, and Mertens 2023; Brynjolfsson et al. 2020), and moved their social

interactions into cyberspace (Nabity-Grover, Cheung, and Thatcher 2020). Such lifestyle transformations could have serious ramifications for personal preferences over payment methods.

A question arises as to whether these lifestyle changes have become habitual and therefore enduring. We need to bear in mind that focal attention and consciousness of choice feature prominently when an action is performed for the first time. The more an activity is repeated in a stable context, the more automatic the cognitive processes become, thereby permitting speedy action (Carden and Wood 2018; Shiffrin and Schneider 1977). Lally et al. (2010) examined changes in daily routines in order to gauge how long it would take an individual to develop a new habit. In their research, the participants' median time to reach a "plateau of automaticity" was 66 days. The duration of the pandemic has exceeded this estimate by a substantial margin, allowing sufficient time for habit formation. Arguably, the context could be also viewed as stable in the sense that the possibility of infection was ubiquitous and ever-present. However, there is a fair amount of uncertainty as to how people would behave if the context were to change. For instance, the epidemic could be eradicated through a program of mass vaccination. In response to this, some individuals may remain entrenched in the habits they acquired, while others may devote more attention to accommodating the altered landscape in their decisionmaking. Any persistence of COVID-induced habits could affect general attitudes towards using cash in the long run. Our questionnaire deliberately asks respondents which of their behavioral changes are likely to endure one year after the end of the COVID-19 pandemic.

3. Methodology

Two dependent dummy variables are considered in our modeling. They record whether respondents started to use more cashless payments due to the COVID-19 pandemic (*Cashless Switch*) and whether they declare an intention to use cashless payments more often after the pandemic is over (*Cashless Intention*). Since our data set is cross-sectional rather than longitudinal in nature, we are unable to verify whether the declared intentions materialize as an actual behavior in the future. However, extant empirical evidence indicates that, when it comes to adopting technologies,

there is a high correlation between intentions and actual subsequent usage (see, for instance, Davis 1989). Perhaps more importantly, the behavioral intention is considered an antecedent and a stimulus for technology adoption in the most prominent theoretical models, such as the theory of reasoned action (Ajzen and Fishbein 1980; Fishbein and Ajzen 1975) or the technology acceptance model (Davis 1989).

Since our dependent variables measuring whether a respondent switched or intends to switch to cashless payments are binary in nature, our analysis relies on traditional logit regressions (Hosmer, Lemeshow, and Sturdivant 2013). Consequently, we estimate the probability of the act or intention to switch by employing the following empirical model:

$$P(Y^i_{jk} = 1|H_{jk},\ E_k,\ C_{jk}) = \frac{1}{1 + e^{-(\alpha+\beta(H_{jk})+\varphi(E_k)+\gamma(C_{jk}))}} \quad (1)$$

Two variants ($i \in \{1, 2\}$) of the dependent variable Y^i are used in the main analysis and the robustness check section, representing either *Cashless Switch* or *Cashless Intention*. Depending on the value of i, the outcome $Y^i = 1$ indicates that the person either switched to cashless payments or wishes to do so in the future; H_{jk} is the vector that measures the characteristics, perceptions, and confidence in using technology of person j living in country k; E_k is a vector of specific characteristics of country k; while C_{jk} is our core vector of COVID-19-induced fears and changes in the behavior of person j living in country k.

Our sampling uses stratification by age, gender, and size of locality, and the survey spans 22 European countries. However, the sample size in each of the nations is not necessarily proportional to its population of Internet users. To remedy this issue methodologically, we proceed to calculate the actual proportions of Internet users for each country and, in our estimation, we weight each observation by the inverse of its probability of being sampled. In other words, the higher the weighting, the higher the observation's contribution to the residual sum of squares. Such an approach is commonly used in the literature (see, for instance, Moro et al. 2020). We note in passing that unweighted estimation results lead to identical conclusions regarding the processes being modeled.

Since the standard variance-covariance matrix is no longer appropriate, we use a sandwich (White 1980) estimator to compute it.

Robust estimation of standard errors is relied upon to deal with heteroskedasticity issues. When fitting the regressions, we take necessary precautions to avoid multicollinearity problems. This is accomplished by performing factor analysis that aggregates cognate questionnaire items into a construct. Most notably, we consider two factors representing the change in habits related to the COVID-19 epidemic, which have the potential to explain the curbed appetite for cash and transcend purely fear-based rationalization.

4. Data

Collection of the data used in this study was supported by a research grant awarded by the Polish National Science Centre and was implemented by a research agency, Interactive Research Center. The source data were obtained from consumers through a survey based on computer-assisted web interviews (CAWI), which utilized an interactive Internet questionnaire. Internet users were invited to register their interest in participating through e-mail and advertising campaigns. Those who volunteered collected points that were redeemable for prizes. Survey respondents were then selected through stratified sampling from the pool of registrants. Such a data collection approach permitted us to obtain a large sample in a relatively cost-effective manner. The interactive nature of the survey afforded us the opportunity to incorporate additional clarifications and definitions of the technical terms that could be accessed by respondents without the need to exit the webpage. CAWI also allowed participants to pause and save the answers that have already been submitted, facilitating thereby the process of consulting external information sources whenever needed.

The data collection exercise was preceded by a pilot study involving 230 respondents from 22 countries. The overriding aim of this undertaking was to verify whether respondents understand and interpret the questionnaire items correctly. Minor irregularities that were identified in the questionnaire were subsequently rectified and there was no need to conduct a second pilot study. The final sample, collected during the period spanning July to August 2020, includes 5,504 respondents from 22 European countries (Austria, Belgium, Bulgaria, Czech Republic, Denmark, Finland,

France, Germany, Greece, Hungary, Ireland, Italy, Lithuania, the Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Spain, Sweden, United Kingdom). According to Eurostat (2020), the number of Internet users in those countries accounted for 96 percent of all Internet users in the European Union in 2019.

Our survey was conducted online as, due to the pandemic, conducting face-to-face interviews would not have been possible. Since only individuals with Internet access could participate, this raises a question of whether our sample is sufficiently representative of the entire population in terms of the problem studied. To assess the gravity of this problem, we collect Eurostat data on the prevalence of Internet use in the countries of interest. The country-level statistics (presented in Appendix A) were subsequently weighted by population (taken from the World Development Indicators, WDI, database) to arrive at a sample average. The 2020 statistics indicate that proportion of individuals who used Internet in the last 12 months was 90.5 percent, while the proportion of people who have ever used it stood at 92.0 percent. Fortunately, the issue of potential nonrepresentativeness may be even less significant than these statistics would indicate for reasons elucidated in Grewenig et al. (2023). They show that although it may be possible that onliners and offliners differ in their answering behavior, once both groups are interviewed in the face-to-face mode and individuals' background/demographic characteristics are controlled for, the statistical differences between the groups evaporate. We would like to note that our regressions account for demographic factors, which is likely to reduce the size of any possible bias arising from sampling to a tolerable level.

The data collection process employed stratified random sampling, with age, gender, and size of the respondent's locality acting as stratification factors. The stratification factors of gender, age, and size of locality are also used as controls in our regressions. Another control variable employed is the attitude towards privacy, which was quantified through a questionnaire item stating: "I prefer payments for shopping to be anonymous, so that no one can see what I bought and when." The possession of a card, mobile, or wearable that could be used at the point of sale is captured by the dummy variable *Cards & Mobile*. Individuals who are lacking such items face higher costs of switching to cashless technologies, in that they may be forced to open a bank account or acquire the requisite device. We also consider eight

other variables that measure the respondents' perceptions, experience, technological literacy, and habits and that are built up as constructs using principal component factor analysis (Hair et al. 2013). Each of these constructs includes many highly correlated items that cannot be modeled separately due to multicollinearity problems.

The first set of factors examines the assessment of alternative cashless payment methods, namely NFC (or near-field communication) contactless payments like Google Pay, Apple Pay, or payments with wearables (smartwatches, smartbands), and QR (quick response) code payments. Each payment method is assessed across several dimensions using a five-point Likert scale, and one factor for each of the dimensions is subsequently extracted. These factors are labeled as *Convenience of Cashless Payments*, *Safety of Cashless Payments*, *Access to Cashless Payments Technologies, Ease of Use of Cashless Technologies*, and *Control over Finance with Cashless Payments*. Familiarity with technologies was encapsulated in three additional factors. The first one, called *Literacy in Using Mobile Apps*, is based on five items assessing how confident the surveyed person is in using mobile apps for transport (e.g., Uber, Bolt, Freenow), food delivery, buying tickets on public transport, paying parking fees, and tracking fitness activity. Moreover, we measure experience in using payment technologies such as Apple Pay, Google Pay, Amazon Pay, Alipay, MoneyGram, Samsung Pay, WeChat Pay, Western Union, Revolut, cryptocurrencies, and HCE (host card emulation, or mobile contactless in a card-issuer app). Principal component analysis suggests extraction of two factors (eigenvalues of 2.91 and 1.18) that are subsequently rotated using varimax rotation. The items that load clearly in one factor measure *Experience in Using Computer Payments*, while the second factor captures *Experience in Using Mobile Payments*.

Furthermore, our questionnaire comprised a series of items pertaining to habit formation during the pandemic. These items were prefaced by a request to provide an assessment of how the respondent's life will change one year after the COVID-19 pandemic is over, as compared to the time before it started. Responses to these questions were recorded on a five-point Likert scale. The first variable measured the impact of the pest on working habits ("I will work more remotely"), while the second one was designed to capture a possible increase in online activity as a substitute for physical contact

("I will meet people online more frequently"). We also endeavored to explore a shift in traveling patterns ("I will travel less in my country" and "I will travel less abroad"), as well as dining habits ("I will eat more frequently at home"). Finally, we evaluated whether COVID-19 affected personal perception of health ("I will be more focused on my health") and shopping preferences ("I will buy more online"). Two factors with eigenvalues of 2.97 and 1.01 are extracted from these predictions of future habits. The items that load clearly on the first factor capture *Change in Habits Related to Physical Contact*, while the second one clearly gauges *Change in Online Habits*.

All of the eight above-mentioned factors created for the purpose of this study underwent a rigorous process of verification with respect to internal consistency and sampling adequacy. Statistics related to this verification are reported in Table 1. By default, each of the constructs has an eigenvalue above unity. Reassuringly, the Cronbach's alphas are consistently above the recommended threshold of 0.60. The Keiser-Meyer-Olkin test does not detect any sampling inadequacy requiring remedial action, and the proportion of variance explained by the factors appears to be satisfactory.

Moving away from factors, we explore another measure that is critical to our investigation. It intends to capture individual fear related to the possibility of contracting the disease through contact with cash. However, one needs to bear in mind that measurement must be done in relative terms. Respondents will be deterred from using cash for transitional purposes only if they perceive its infection risk to be higher than that for cashless instruments. For this reason, there was a need to include two items in the questionnaire which read "I am afraid of contracting COVID-19 due to the usage of cash in physical stores" and "I am afraid of contracting COVID-19 as a result of operations with cashless payments in physical stores." By taking the difference between the responses to these two questions, we construct a variable called *Net Fear of Cash*. Since the original items were measured on a five-point scale, the resultant net fear variable ranges from -4 to $+4$.

Finally, we utilize three variables that are measured at the country level. We include the cumulative number of COVID-19 deaths (in thousands) that occurred prior to July 2020 in order to consider the general impact that the pandemic had in a given country. Furthermore, the estimated size of the shadow economy in 2016 (as

Table 1. Characteristics of Factors Used in the Study

Factor	Eigenvalue	Cronbach's Alpha	Proportion of Variance Explained	Kaiser-Meyer-Olkin Measure
Convenience of Cashless Payments	3.6510	0.8665	0.7302	0.8751
Safety of Cashless Payments	3.9730	0.9346	0.7945	0.8897
Access to Cashless Payments Technologies	3.7631	0.9161	0.7526	0.8735
Ease of Use of Cashless Technologies	3.8451	0.9236	0.7690	0.8774
Control over Finance with Cashless Payments	4.1703	0.9495	0.8341	0.8968
Literacy in Using Mobile Apps	2.3729	0.7208	0.4746	0.7818
Experience in Using Computer Payments *Experience in Using Mobile Payments*	2.1871 1.9133	0.6027	0.3701	0.8265
Change in Habits Related to Physical Contact *Change in Online Habits*	2.9795 1.0172	0.7722	0.5710	0.8265

a percentage of GDP) was considered as an explanatory variable for cash preferences arising from tax evasion and illegal activities. These estimates were sourced from Kelmanson et al. (2019). Lastly, we create a variable measuring the number of EFT-POS terminals per 1,000 inhabitants in 2020 based on the data published by Bank for International Settlements (2022), ECB (2022), and Norges Bank (2020).[1]

Table 2 provides definitions of all the variables used in the study, while Table 3 reports the corresponding summary statistics. Evaluation of these statistics paints a picture of the individuals involved in our survey. An average respondent resided in a city with less than 100,000 inhabitants and was 47 years of age. The latter figure was influenced by the fact that people under the age of 18 were not invited to participate. Women constituted 52 percent of the sample, which is representative of the broader population in the countries of interest. On average, those who were surveyed showed a slight preference towards payment anonymity but tended to pay primarily with cards and mobiles at the point of sale. When analyzing Table 3, one needs to bear in mind that all the constructs created through factor analysis have a mean of zero and a standard deviation of one.

Importantly, 41 percent of people declared that they use cashless payments more often during the COVID-19 crisis, while 47 percent stated that they will use cashless payments more frequently after the pandemic is over. An average respondent believed that the risk of contracting the coronavirus is slightly higher for cash than the cashless alternatives. Appendix B provides more detailed data in this regard by presenting a breakdown of the key variables by country. Judging from these statistics, respondents who were most keen to switch from cash to digital payments during the pandemic resided in the United Kingdom, Belgium, Ireland, and Portugal. In those countries, people were also more likely to declare their intention to further increase the frequency of cashless payments after the pandemic has been eradicated. Such behavior could be explained by the above-average fear of virus transmission through cash as compared

[1]Since the 2020 data had two missing observations (Bulgaria and Norway), we resorted to using 2019 figures for these two countries. In our judgment, this is a sensible solution since the state of the payment infrastructure does not change rapidly on a year-to-year basis.

Table 2. Definitions of Variables

Variable	Definition
Cashless Switch	A binary variable taking the value of one for the response "Yes, I pay more often cashless (by card, smartphone, smartwatch)" to the questionnaire item "Has the coronavirus pandemic (COVID-19) affected how you pay in physical stores?". The responses "Yes, I pay more cash," "Not affected (I pay the same way as I did before pandemic," "I do not know," and "I did not make any purchases during pandemic" are coded as zero.
Cashless Intention	Dummy variable measuring respondent's agreement with the statement "After the pandemic, I will use cashless payments more often" (1 = yes, 0 = no)
Gender	Dummy variable capturing respondent's gender (1 if female, 0 otherwise)
Location Size	Response to a question regarding the size of the location (including suburbs) where the respondent lives. Responses are coded on a six-point scale: 1 – Rural area 2 – City with less than 50,000 inhabitants 3 – City between 50,000 and 100,000 inhabitants 4 – City between 100,000 and 500,000 inhabitants 5 – City between 500,000 and 1,000,000 inhabitants 6 – City over 1,000,000 inhabitants
Age	Age of the respondent
Cards & Mobile	A dummy variable measuring the possession of any card, mobile, or wearable applicable at the point of sale (1 = yes, 0 = no)
Anonymity	Degree of agreement with a statement "I prefer payments for shopping to be anonymous, so that no one can see what I bought and when" measured on a five-point Likert scale (1 = strongly disagree, 5 = strongly agree)
Convenience of Cashless Payments	A factor aggregating assessments of convenience of five different cashless payment technologies (contactless (NFC) payments, Google Pay, Apple Pay, QR code payments, contactless payments with wearables)
Safety of Cashless Payments	A factor combining perceptions of safety of five different cashless payment technologies
Access to Cashless Payments Technologies	A factor aggregating assessments of how widespread five different cashless payment instruments are
Ease of Use of Cashless Technologies	A factor extracted from evaluations of how easy to use five cashless payment technologies are

(*continued*)

Table 2. (Continued)

Variable	Definition
Control over Finance with Cashless Payments	A factor constructed from an assessment of how much control over personal finance is afforded by five different cashless payment technologies
Literacy in Using Mobile Apps	A factor aggregating five items assessing how confident the surveyed person is in using mobile apps for transport (e.g., Uber, Bolt, Freenow), food delivery, buying tickets on public transport, paying parking fees, and tracking fitness activity
Experience in Using Computer Payments	First factor extracted from the items measuring respondent's experience in using payment technologies such as Apple Pay, Google Pay, Amazon Pay, Alipay, MoneyGram, Samsung Pay, WeChat Pay, Western Union, Revolut, cryptocurrencies, and HCE. The items that load clearly relate to computer-based payments.
Experience in Using Mobile Payments	Second factor extracted from the items measuring respondents' experience in using payment technologies such as Apple Pay, Google Pay, Amazon Pay, Alipay, MoneyGram, Samsung Pay, WeChat Pay, Western Union, Revolut, cryptocurrencies, and HCE. The items that load clearly relate to mobile-based payment technologies.
Change in Habits Related to Physical Contact	First factor extracted from items "I will work more remotely," "I will meet people online more frequently," "I will travel less in my country," "I will travel less abroad," " I will eat more frequently at home," and "I will be more focused on my health" after the COVID-19 crisis is over. The items that load heavily are related to physical contact.
Change in Online Habits	Second factor extracted from items "I will work more remotely," "I will meet people online more frequently," "I will travel less in my country," "I will travel less abroad," " I will eat more frequently at home," and "I will be more focused on my health" after the COVID-19 crisis is over. The items that load heavily are related to online habits.
Net Fear of Cash	A variable constructed by taking the difference in responses to two questionnaire items: "I am afraid of contracting COVID-19 due to the usage of cash in physical stores" and "I am afraid of contracting COVID-19 as a result of operations with cashless payments in physical stores."
COVID Deaths	Total number of COVID-19 deaths (in thousands) for the country in which the respondent resides
Shadow Economy	Size of the shadow economy as a percentage of GDP in the respondent's country of residence
Number of EFT-POS Terminals per Thousand People	Number of terminals provided by resident payment service providers per thousand inhabitants

Table 3. Summary Statistics

Variable	Mean	Standard Deviation	Minimum	25th Percentile	Median	75th Percentile	Maximum
Cashless Switch	0.47	0.50	0.00	0.00	0.00	1.00	1.00
Cashless Intention	0.41	0.49	0.00	0.00	0.00	1.00	1.00
Gender	0.52	0.50	0.00	0.00	1.00	1.00	1.00
Location Size	2.77	1.57	1.00	1.00	2.00	4.00	6.00
Age	47.04	16.31	18.00	33.00	47.00	62.00	100.00
Cards & Mobile	0.90	0.30	0.00	1.00	1.00	1.00	1.00
Anonymity	3.28	1.12	1.00	3.00	3.00	4.00	5.00
Convenience of Cashless Payments	0.00	1.00	–2.05	–0.45	–0.06	0.67	1.94
Safety of Cashless Payments	0.00	1.00	–2.29	–0.21	–0.02	0.80	1.88
Access to Cashless Payments Technologies	0.00	1.00	–2.37	–0.36	–0.14	0.56	2.09
Ease of Use of Cashless Technologies	0.00	1.00	–2.59	–0.45	–0.07	0.62	1.70
Control over Finance with Cashless Payments	0.00	1.00	–2.36	–0.29	–0.29	0.74	1.78
Literacy in Using Mobile Apps	0.00	1.00	–0.88	–0.88	–0.31	0.52	2.42
Experience in Using Computer Payments	0.00	1.00	–1.36	–0.20	–0.20	–0.20	9.66
Experience in Using Mobile Payments	0.00	1.00	–2.97	–0.52	–0.52	0.43	5.90
Change in Habits Related to Physical Contact	0.00	1.00	–2.93	–0.53	–0.02	0.61	2.56
Change in Online Habits	0.00	1.00	–3.64	–0.59	0.16	0.68	3.19
Net Fear of Cash	0.24	1.01	–4.00	0.00	0.00	0.00	4.00
COVID Deaths	8.49	5.18	2.47	4.99	6.25	11.48	20.98
Shadow Economy	21.98	7.18	9.60	16.70	20.30	27.80	37.80
Number of EFT-POS Terminals per Thousand People	30.35	13.97	13.18	23.01	26.79	32.99	71.11

Note: Definitions of the variables can be found in Table 1. The number of observations for each of the variables listed above is 5,504.

to cashless alternatives as well as significant shifts in habits spanning both the physical and virtual realms.

Another point of interest is the joint distribution of the two dependent variables in our study. The data reported in Appendix C reveals that the values of *Cashless Switch* and *Cashless Intention* coincide for 70.35 percent of respondents. This is unsurprising, as these variables are expected to have common covariates. When we partition our sample based on the values of the two dependent variables, we discover that significant differences in the average value of *Net Fear of Cash* emerge across different subgroups. This preliminary result indicates that the fear of infection through handling physical currency is determining payment behavior.

5. Empirical Results

Table 4 presents the results of weighted logit regressions estimating the likelihood of an immediate increase in the frequency of cashless payments in response to the COVID-19 pandemic. The first specification focuses on the fear of contagion via cash, while the second one considers the impact of changing habits. Regression (3) subsumes both these determinants as well as a full set of controls, making it the most comprehensive model amongst the considered alternatives. With respect to the key explanatory variables, our empirical findings cohere with a priori predictions. *Net Fear of Cash* is positively signed and exhibits a strong statistical significance. Clearly, individuals who believe that handling cash poses a relatively serious health hazard tend to enthusiastically embrace cashless instruments. The t-statistics associated with the variable *Change in Habits Related to Physical Contact* exceed the value of 10, making it another strong predictor of payment behavior. In other words, respondents who declared an intention to alter their routines in the physical world were ceteris paribus more likely to use cashless payment methods at the point of sale. *Change in Online Habits* appears to be a further important explanatory factor, albeit the magnitude of its coefficient and its explanatory power pales in comparison to the *Change in Habits Related to Physical Contact*. One may therefore argue that, when it comes to choices of payment technologies, habits in the physical sphere are of greater consequence than those in the virtual realm.

Table 4. Modeling the Switch to Cashless Payments during the Pandemic

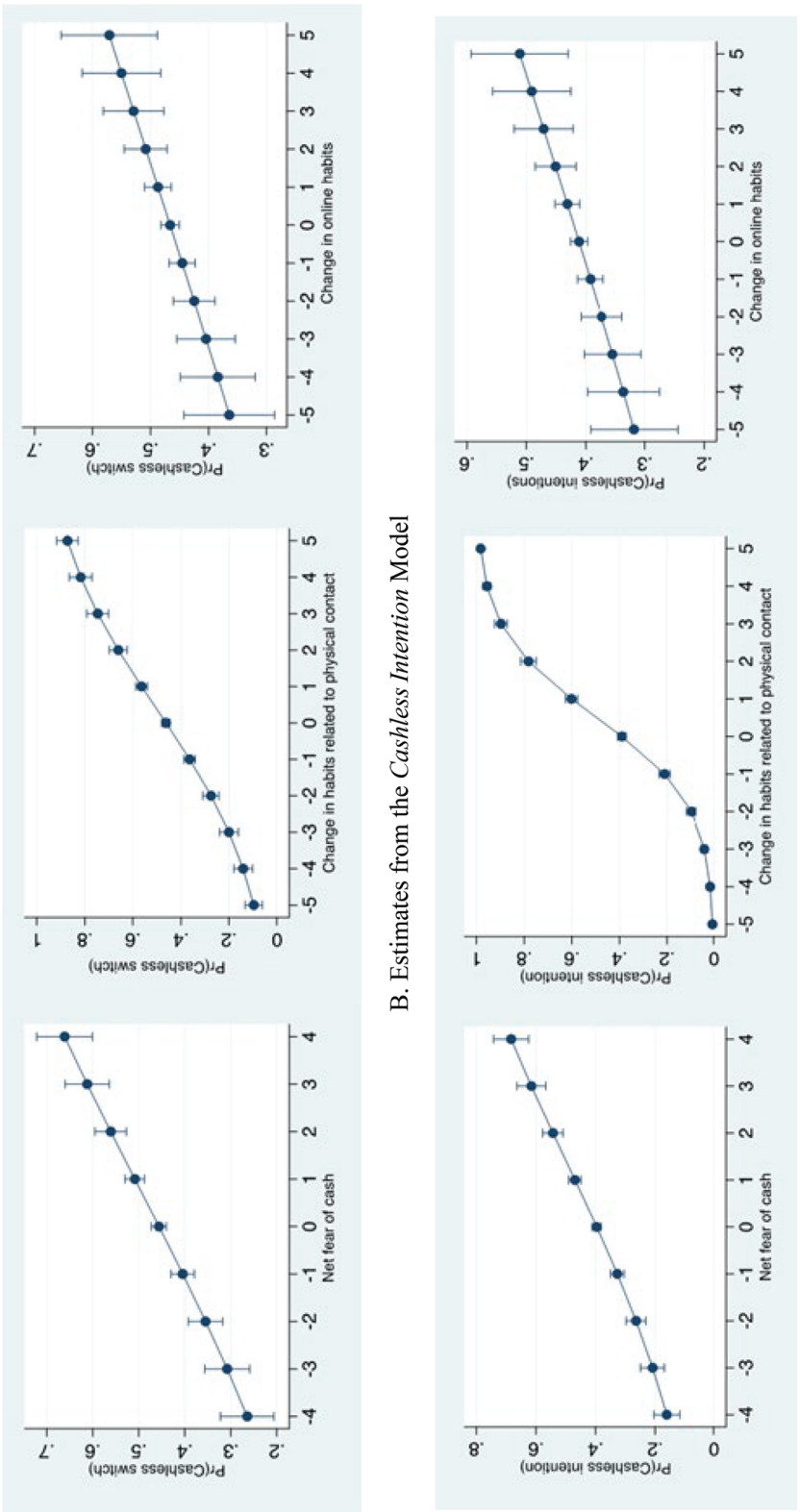
	(1)	(2)	(3)
Gender	0.1764**	0.1528**	0.1597**
	(0.0762)	(0.0774)	(0.0778)
Location Size	0.0265	0.0150	0.0189
	(0.0249)	(0.0253)	(0.0255)
Age	0.0047*	0.0066**	0.0063**
	(0.0025)	(0.0026)	(0.0026)
Cards & Mobile	0.6695***	0.7438***	0.7286***
	(0.1323)	(0.1334)	(0.1336)
Anonymity	–0.0560*	–0.1230***	–0.1082***
	(0.0335)	(0.0346)	(0.0349)
Convenience of Cashless Payments	0.0079	–0.0261	–0.0210
	(0.0534)	(0.0559)	(0.0560)
Safety of Cashless Payments	0.1188**	0.1245**	0.1140*
	(0.0594)	(0.0598)	(0.0604)
Access to Cashless Payments Technologies	0.0247	–0.0431	–0.0360
	(0.0535)	(0.0547)	(0.0552)
Ease of Use of Cashless Technologies	0.1515**	0.1707***	0.1600***
	(0.0601)	(0.0616)	(0.0617)
Control over Finance with Cashless Payments	0.0107	–0.0210	–0.0244
	(0.0530)	(0.0536)	(0.0544)
Literacy in Using Mobile Apps	0.3763***	0.3655***	0.3630***
	(0.0467)	(0.0469)	(0.0472)
Experience in Using Computer Payments	0.0631*	0.0166	0.0219
	(0.0361)	(0.0369)	(0.0373)
Experience in Using Mobile Payments	0.0420	0.0172	0.0195
	(0.0442)	(0.0460)	(0.0457)
COVID Deaths	0.0245***	0.0174**	0.0183**
	(0.0072)	(0.0074)	(0.0075)
Shadow Economy	–0.0132**	–0.0192***	–0.0201***
	(0.0057)	(0.0058)	(0.0058)
Number of EFT-POS Terminals per Thousand People	0.0031	0.0002	0.0011
	(0.0025)	(0.0025)	(0.0026)
Net Fear of Cash	0.2812***		0.2431***
	(0.0389)		(0.0399)
Change in Habits Related to Physical Contact		0.4748***	0.4526***
		(0.0421)	(0.0422)
Change in Online Habits		0.0981**	0.0984**
		(0.0392)	(0.0394)
Constant	–1.0736***	–0.6432**	–0.7457**
	(0.2822)	(0.2883)	(0.2907)
Observations	5,504	5,504	5,504
chi2	343.0	391.3	429.5
p-value	0	0	0
McFadden's Pseudo R-squared	0.0885	0.108	0.117

Note: This table reports regression coefficients of weighted logit regressions in which *Cashless Switch* acts as a dependent variable. Variable definitions can be found in Table 2. Robust standard errors are shown in parentheses. ***, **, and * denote statistical significance at 1 percent, 5 percent, and 10 percent, respectively.

While the statistical significance of fear and habits is unequivocal, the question arises as to the economic significance of our results. To probe this issue, we plot predictive functions in panel A of Figure 1. More specifically, these plots show the expected probability of *Cashless Switch* = 1 when one key independent variable is varied, and the remaining regressors are kept constant at the sample average value. When interpreting the values on the horizontal axis, one needs to remember that *Net Fear of Cash* was derived from differencing two five-point Likert scales, while a unitary move across the x-axis for the habit variables denotes a change equivalent to one standard deviation. Clearly, probabilities are increasing monotonically with all three of the variables considered in panel A, with the increase being remarkably steep for *Net Fear of Cash* and *Change in Habits Related to Physical Contact*. Judging from the plots, these two factors were decisive for many respondents in their decision to abandon cash payments at POS during the COVID-19 crisis.

The influence of statistically significant control variables warrants further discussion. Females and those who are literate in using mobile apps showed greater proclivity to embrace cashless technologies. Unsurprisingly, those without access to cashless instruments remained dependent on banknotes and coins during the COVID crisis. Since older individuals face higher SARS-CoV-2 fatality rates (O'Driscoll et al. 2021), their health risk arising from engagement in cash-based transactions is graver. Cognizant of this reality, older people relinquished payments with physical currency more readily. Apprehension over anonymity issues and the influence of shadow economy thwarted individuals' transition towards cashless transacting. Respondents with no concerns over safety of digital payment technologies were more likely to use them frequently, which mirrors the argument of Ostlund (1974) that the perceived risk of an innovation hinders its diffusion. Furthermore, in line with the theoretical predictions of the technology acceptance model of Davis (1989), perceived ease of use of cashless instruments correlated positively with their adoption. Lastly, the number of COVID-related deaths in the respondent's country of residence was a factor contributing to the abandonment of cash. The number of deaths captures general concern over the pandemic, which goes beyond change in habits and fear of using cash captured by other variables in the model.

Figure 1. Marginal Effects for the Key Explanatory Variables



Note: The plots show a prediction of probability that either *Cashless Switch* = 1 (panel A) or *Cashless Intention* = 1 (panel B) when one of the key explanatory variables is changed, while the remaining explanatory variables are kept constant at the sample average level. The vertical bars represent 95 percent confidence intervals. The graphs in panel A are derived based on logit regression (3) in Table 4, while panel B relied on regression (3) in Table 5.

Table 5 reports weighted logit estimates for models considering the intention to use more cashless transactions after the COVID-19 pandemic is over. The results indicate that COVID-induced fear of cash may have a long memory and is likely to extend into the distant future. Once again, *Change in Habits Related to Physical Contact* exhibits stronger statistical significance and has a larger marginal effect than *Change in Online Habits* (see panel B of Figure 1). Juxtaposition of the results with those contained in Table 4 reveals that the coefficients on the fear and change in habits variables are notably larger, which coheres with our expectations. Table 4 models actual changes in behavior, while Table 5 considers reported intentions to alter behavioral patterns in the future. Since forming an intention requires less effort on the part of the respondent than taking an actual action, the parameter estimates in Table 5 are expected to be larger.

Broadly speaking, a similar pattern of significance emerges across control variables. A slight discrepancy that could be noted is the weaker explanatory power of *Age* and *Shadow Economy.* It appears that older people, who are in the highest risk group, may be reluctant to increase the frequency of their cashless payments relative to the pandemic level after the health perils have dissipated. The diminished statistical significance of the shadow economy could reflect the fact that its future size is essentially unknown and, consequently, this variable plays a smaller role in shaping intentions. The protracted pandemic is expected to have a disproportionate effect on the informal economy, where workers without formalized contracts lack job security and do not benefit from furlough schemes (Webb, McQuaid, and Rand 2020).

The economic significance of the control variables can be assessed using the average marginal effects reported in our Appendix D. What can be gleaned from these estimates is that the variable with the most pronounced economic impact is *Cards & Mobile*, regardless of whether we model the *Cashless Switch* or *Cashless Intention.* The average marginal effect for *Literacy in Using Mobile Apps* proved large for the instantaneous increase in cashless payment frequency during the pandemic but was notably attenuated in the regression considering post-pandemic payment intentions. What mattered more from the point of view of agreement with the statement "After the pandemic, I will use cashless

Table 5. Modeling the Intention to Use More Cashless Payments after the Pandemic Is Over

	(1)	(2)	(3)
Gender	0.1980**	0.1606*	0.1772**
	(0.0787)	(0.0829)	(0.0843)
Location Size	0.0256	0.0081	0.0133
	(0.0252)	(0.0270)	(0.0272)
Age	0.0023	0.0054*	0.0046
	(0.0026)	(0.0029)	(0.0029)
Cards & Mobile	0.5743***	0.7547***	0.7324***
	(0.1431)	(0.1424)	(0.1438)
Anonymity	0.0087	–0.1326***	–0.1125***
	(0.0346)	(0.0384)	(0.0391)
Convenience of Cashless Payments	0.0699	0.0233	0.0290
	(0.0554)	(0.0613)	(0.0620)
Safety of Cashless Payments	0.2486***	0.2768***	0.2715***
	(0.0629)	(0.0693)	(0.0700)
Access to Cashless Payments Technologies	0.0520	–0.0876	–0.0789
	(0.0569)	(0.0639)	(0.0651)
Ease of Use of Cashless Technologies	0.1901***	0.2330***	0.2137***
	(0.0635)	(0.0707)	(0.0717)
Control over Finance with Cashless Payments	0.1214**	0.0696	0.0714
	(0.0543)	(0.0595)	(0.0609)
Literacy in Using Mobile Apps	0.1517***	0.1288**	0.1197**
	(0.0469)	(0.0508)	(0.0514)
Experience in Using Computer Payments	0.1186***	0.0361	0.0467
	(0.0396)	(0.0410)	(0.0426)
Experience in Using Mobile Payments	0.0692	0.0314	0.0354
	(0.0458)	(0.0481)	(0.0485)
COVID Deaths	0.0284***	0.0169**	0.0187**
	(0.0074)	(0.0077)	(0.0077)
Shadow Economy	0.0105*	–0.0012	–0.0021
	(0.0059)	(0.0062)	(0.0063)
Number of EFT-POS Terminals per Thousand People	0.0005	–0.0049*	–0.0036
	(0.0025)	(0.0027)	(0.0028)
Net Fear of Cash	0.4408***		0.3955***
	(0.0438)		(0.0472)
Change in Habits Related to Physical Contact		1.0063***	0.9847***
		(0.0547)	(0.0551)
Change in Online Habits		0.1071**	0.1098**
		(0.0441)	(0.0452)
Constant	–1.8385***	–1.0840***	–1.2423***
	(0.2908)	(0.3040)	(0.3115)
Observations	5,504	5,504	5,504
chi2	395.6	537.4	550.6
p-value	0	0	0
McFadden's Pseudo R-squared	0.123	0.205	0.223

Note: This table reports regression coefficients of weighted logit regressions in which *Cashless Intention* acts as a dependent variable. Variable definitions can be found in Table 2. Robust standard errors are shown in parentheses. ***, **, and * denote statistical significance at 1 percent, 5 percent, and 10 percent, respectively.

payments more often" was the safety of the cashless payment instruments.

6. Robustness Checks and Further Results

In order to confirm the validity of the story presented here, further tests and robustness checks were performed. To start with, we experimented with a different constellations and definitions of control variables. Firstly, the variable *Cards & Mobile* measuring the possession of any card, mobile, or wearable applicable at the point of sale was replaced with dummy variables categorizing respondents in accordance with their historical cash usage. The results displayed in Appendix E reveal a rational pattern of behavior. Individuals who made all of their transactions in cash prior to the pandemic were least likely to increase their frequency of cashless payments and showed least inclination to do so in the future. This is unsurprising, as the group includes people who operate in the shadow economy, are financially excluded, or have strong desire for anonymity. These attributes firmly anchor individuals' desire to transact in cash. For the most part, the group that was most motivated to embrace more cashless transactions comprised respondents who historically used cash in 1 percent to 30 percent of their payments. Most importantly, inclusion of the past payment behavior dummies did not change our main conclusions regarding the key explanatory variables.

Secondly, we redefined our measurements of the five attributes of cashless payments (convenience, safety, access, ease of use, and control over finance). Instead of gauging them in absolute terms, we expressed them relative to the perceived characteristics of cash. Appendix F displays our findings which, once again, reaffirm the significance of fear and habit shifts in the formation of payment preferences.

Thirdly, we interrogated the question of whether the effect of the *Age* variable is linear. To this end, we converted the continuous *Age* variable into age-group dummies, which should allow us to pinpoint the age brackets in which respondents were particularly sensitive to COVID concerns (see Appendix G). The results indicate that individuals aged between 60 and 69 were particularly eager to increase the frequency of their cashless payments during the pandemic. Perhaps this could have been attributed to the fact that

COVID mortality within this age group was higher as compared to younger people. In terms of declaring an intention to increase frequency of cashless payments after the pandemic is over, respondents between the ages of 40 to 59 were particularly reluctant to do so.

Another point of inquiry arose from the reflection that respondents who already transacted exclusively cashless in the pre-pandemic period would have the tendency to rate different aspects of such transactions highly. At the same time, they were unable to increase their frequency of cashless payments, as they already resided at the limit. A question therefore arises as to whether our results are sensitive to the exclusion of such individuals. To probe this issue further, we constructed a sample which eliminated people who did not use cash at all in the 12 months preceding the survey ($n = 363$). We rerun the logit regressions on the restricted sample (see Appendix H) and note that our main inferences regarding the three key explanatory variables remain unaltered.

In the next step of our exploration, we investigated whether there are any country-specific factors that moderate the relationship between the COVID pandemic and respondents' willingness to switch to cashless transactions. For this purpose, we created eight dummies that were subsequently interacted with the three key explanatory variables in our study (*Net Fear of Cash* and the two change-in-habits variables). These dummies indicated countries with above-median values recorded for the EFT-POS terminals per thousand people, shadow economy size, COVID deaths, power distance and uncertainty avoidance index from the Hofstede national culture database, GDP per capita expressed in purchasing power parity prices, COVID stringency index measuring the severity of government policy responses, and countries that are Scandinavian. The estimates of logistic regressions imparting these interaction terms, along with their interpretation, are shown in Appendix I.

Finally, we consider an alternative approach to modeling our dichotomous variables by employing weighted probit models. Compared to the logit regressions used in our baseline regressions, this methodological framework makes different assumptions about the error term and is based on a different link function. Reassuringly, our results from this estimation reported in Appendix J corroborate our earlier conclusions, which is a testament to the fact that our inferences are not a mere byproduct of the methodology selected.

7. Practical Considerations

The first sphere that could be affected by the collective switch to cashless transactions is the banking sector. Such shift is positively affecting the profitability of banks in at least two ways. Firstly, payment services are an enduring element embedded in the core operations of commercial banks (Rambure and Nacamuli 2008) and allow them to augment and diversify their revenue streams. Historically, banks derived most of their revenues from acting as intermediaries that take deposits and lend money, earning net interest spread in the process. However, over time, non-interest income[2] became increasingly important (DeYoung and Rice 2004). Among the non-interest revenue streams are those attributable to processing and clearing payment transactions for various parties (Radecki 1999). According to the Federal Deposit Insurance Corporation (FDIC) about 33 percent of U.S. banks' income was classed as non-interest (Li et al. 2021). McKinsey and Company (2022) report that global payments revenues totaled $2 trillion in 2019, increasing to $2.1 trillion in 2021. These figures translate into a rise in the share of banking revenues from about 39 percent to 40 percent.

Secondly, adoption of electronic payment instruments bestows additional benefits upon banks in the form of reduced operating expenses, because the cost of electronic payment equals about one-third to one-half of the paper-based equivalent (Humphrey et al. 2006). Electronic payments are subject to economies of scale, which play a significant role in the unit costs of transactions incurred by banks (Beijnen and Bolt 2009; Bolt and Humphrey 2007; Khiaonarong 2003). These bank incentives are evinced by the rise of cashless branches in which withdrawals, deposits, or check-cashing services are unavailable (Engert and Fung 2019). Emergence of such bank offices is especially conspicuous in Sweden, where about 60 percent of branches had become cashless by 2016, forcing an even greater reduction in cash usage (Engert, Fung, and Segendorf 2020).

For FinTech firms (that is, innovative, technological companies providing financial services) change of payment habits could also have profound impact. Not only do they profit from launching

[2]That is, income arising from sources unconnected to the collection of interest payments (Haubrich and Young 2019).

and operationalizing digital payment innovations, but they are also actively involved in credit markets. Ghosh, Vallee, and Zeng (2021) argue that FinTechs consider cashless payments to be a good source of verifiable information regarding the creditworthiness of a borrower, which forces the prospective loan applicants to adopt them. The customer payment data is leveraged for alternative credit underwriting models in a novel way, creating economic incentives to move away from cash.

Global consultancy firm KPMG (2020) estimates that $361 billion was invested in FinTechs during the 2017–19 period and 58 of those companies hit a valuation of more than $1 billion, becoming so-called unicorns (McKinsey and Company 2020a). The momentous rise of FinTechs and their impact on transforming the financial industry's landscape is undisputed (Gomber et al. 2018; Thakor 2020). Interestingly, about $144.4 billion of the above-mentioned total investment was channeled to companies providing payment services. These companies are referred to as PayTechs and compete with banks for their non-interest revenue streams. The population of PayTechs is growing continuously, with the number of companies that obtained regulatory licenses to provide such services in the European Union soaring from 350 in 2017 to 1,475 in 2020 (Polasik et al. 2020).

Evidence also seems to point to a surge in demand for products offered by FinTech and PayTech companies during the COVID-19 crisis. According to McKinsey and Company (2020b), 6 percent of U.S. consumers opened an overall banking FinTech account during the pandemic, while Fu and Mishra (2022) report a significant rise in downloads of finance mobile apps from Google and Apple app stores during this period. Interestingly, the epidemic-induced uptick in FinTech solutions was not uniformly distributed across countries, with a number of players in the sector struggling to raise funds and balancing precariously on the edge of insolvency (see, for instance, Chernova 2019; Kelly 2020; Kodoth 2020).

Our empirical analysis could be valuable to the banking sector, as well as FinTech and PayTech firms, because it provides a clear guidance for their future marketing efforts. More specifically, it helps to identify groups that are likely to use cashless payment services more frequently in the future and pinpoint attitudes that tend to promote such behavior. Firstly, our findings indicate that women declared

their willingness to increase the frequency of cashless payments more often than men. Advertising campaigns should be tailored accordingly to take full advantage of this fact. Furthermore, any promotions of digital payment instruments should endeavor to reassure the users about their safety. Our respondents attached great importance to this attribute. Similarly, ease of use of digital payment technologies proves to be a powerful stimulus for their adoption. For this reason, a deliberate effort should be undertaken to make the design of payment instruments/applications more user-friendly, without compromising their safety. Any advertising initiatives should also take account of the lasting changes in habits induced by the COVID pandemic and could perhaps attempt to reliably educate about the risk of contracting the virus via handling cash.

Another interesting result reported in this paper relates to the fact that the existence of shadow economy hindered the transition towards digital payments during the COVID-19 period, although this relationship was weaker for the reported future intentions. Vigorous actions of tax authorities and law enforcement agencies aimed at curbing the underground economic activities could potentially foster a more rapid move towards a cashless society. For many years, the shadow economy was perceived to be closely linked to cash transactions (Gordon 1990). Similarly, reduction in cash payments could have a discouraging effect on tax evasion and criminal activities. Zhang et al. (2019) find that an increase in the use of cashless payments helps to shrink and transform the shadow economy, while Schneider (2019) estimates that complete elimination of cash would decrease its size by 20.1 percent. With respect to tax compliance, two studies focusing on Greece and the euro area by Hondroyiannis and Papaoikonomou (2017, 2020) showed that that an increase in the share of card payments in private consumption led to a corresponding growth in VAT (value-added tax) revenues. For Greece, a 1 percentage point rise in this share was estimated to augment the VAT receipts by somewhere between 1 percent (Hondroyiannis and Papaoikonomou 2017) and 1.4 percent (Danchev, Gatopoulos, and Vettas 2020). Studies exploring this issue from the perspective of the whole European Union (most notably Immordino and Russo 2018 and Madzharova 2020) cohere with the conclusion that cashless payments tend to reduce VAT tax evasion.

Changes in how people pay are also critical for central banks, as these institutions are sole issuers of money and play a key role in its distribution. As shown in Subsection 2.2, the share of cash payments in retail transactions has decreased worldwide and transactional use of cash plunged even further during the COVID-19 epidemic. This, however, was eclipsed by precautionary hoarding of cash, which led to an increase in the overall demand for money (see, for instance, Caswell et al. 2020; Chen et al. 2020; Goodhart and Ashworth 2020; Kotkowski 2023). Whatever the demand, central banks need to be ready to provide an adequate supply of physical money at all times, in addition to performing their role as monetary authorities and safeguarding the financial system (Restoy 2020). This issuing obligation is especially important during times of distress, such as the COVID-19 pandemic, because failure to meet the surge in demand could heighten reputational risk. Additionally, central banks must be aware that the elevated demand would not last forever, and that they may be forced to withdraw and redeem some of the cash that is currently in circulation (Snellman, Vesala, and Humphrey 2001).

8. Conclusions

The coronavirus epidemic instilled a widespread sense of apprehension and changed the trajectories of our lives. In this paper, we examined how the disease outbreak affected consumer choices regarding payment methods at the point of sale. The results clearly indicate that those who believed that cash poses a relatively high risk of viral transmission opted for cashless alternatives. Payment behavior was also indirectly transmuted through the impact that the pandemic had on the patterns of our daily activities. Especially, our altered habitual conduct in physical spaces exerted a powerful influence, steering individuals towards cashless transactions. The drift away from physical currency was also attributable to changes in online behavior, albeit to a lesser degree. Interestingly, the possibility of contagion through cash and transformed habits not only drove the contemporaneous switch between the payment instruments but also imprinted themselves on respondents' future intentions to transact in a cashless manner, even after the COVID pandemic has been contained.

Our findings have several practical implications relevant to every link in the chain of payment transaction processing. Banks, acquirers, FinTechs, and payment organizations must be aware that COVID-like events can drastically change the volume and value of processed transactions. While in some cases it may bring a much-needed revenue stream, it also puts a strain on available resources. Failure to meet the surge in demand could heighten reputational risk. Similarly, merchants need to show flexibility in times perturbed by fear of disease contagion and dynamically evolving consumer habits. Preferred payment options should be offered to paying patrons to alleviate their anxiety. Furthermore, central banks should carry out further studies on the epidemiological safety of different payment instruments, so conclusive knowledge about this phenomenon could emerge and potentially ease angst within the population. Finally, the COVID-induced speedy move towards digital payments has the potential to disadvantage those who are financially excluded, particularly immigrants, elderly, unemployed, or disabled people. This area of concern warrants further scientific inquiry in the future.

Appendix A

Table A.1. Internet Use in Our Sample Countries in 2020

	Individuals Who Used Internet in the Last 12 Months (in %)	**Individuals Who Have Ever Used the Internet (in %)**	**Population**
Austria	89	92	8,917,205
Belgium	92	94	11,555,997
Bulgaria	74	79	6,934,015
Czech Republic	89	92	10,698,896
Denmark	99	99	5,831,404
Finland	97	98	5,530,719
France*	91	93	67,391,582
Germany	95	96	83,240,525
Greece	79	80	10,715,549
Hungary	86	88	9,749,763
Ireland	92	94	4,994,724
Italy	81	84	59,554,023
Lithuania	84	86	2,794,700
Netherlands	95	96	17,441,139
Norway	98	99	5,379,475
Poland	85	87	37,950,802
Portugal	79	82	10,305,564
Romania	85	86	19,286,123
Slovak Republic	91	93	5,458,827
Spain	93	94	47,351,567
Sweden	97	98	10,353,442
United Kingdom	98	98	67,215,293
Population-Weighted Average	90.5035	92.0413	

*Due to the lack of data, we use 2019 statistics for France.
Note: Internet use data are sourced from Eurostat, while the population data come from WDI. Survey consists of all individuals aged 16 to 74. On an optional basis, some countries collect separate data on other age groups: individuals aged 15 years or less, aged 75 or more.

Appendix B

Table B.1. Country-Level Averages for the Key Variables

	Cashless Switch	*Cashless Intention*	*Net Fear of Cash*	*Change in Habits Related to Physical Contact*	*Change in Online Habits*
Austria	0.39	0.28	0.06	–0.24	–0.14
Belgium	0.63	0.48	0.32	0.01	0.08
Bulgaria	0.29	0.34	0.28	0.17	0.01
Czech Republic	0.43	0.35	0.25	–0.15	–0.02
Denmark	0.42	0.34	0.41	–0.18	–0.10
Finland	0.41	0.38	0.16	–0.13	–0.01
France	0.42	0.37	0.14	–0.05	0.01
Germany	0.34	0.31	0.09	–0.22	–0.21
Greece	0.47	0.33	0.03	–0.18	0.12
Hungary	0.34	0.39	0.37	–0.10	–0.21
Ireland	0.63	0.51	0.35	0.20	0.06
Italy	0.40	0.38	0.10	0.23	–0.05
Lithuania	0.31	0.39	0.22	–0.08	0.01
Netherlands	0.56	0.38	0.18	–0.10	0.14
Norway	0.47	0.38	0.11	–0.22	–0.07
Poland	0.56	0.53	0.44	0.09	0.07
Portugal	0.61	0.57	0.31	0.35	0.07
Romania	0.55	0.55	0.39	0.43	0.00
Slovakia	0.39	0.33	0.23	–0.15	0.08
Spain	0.49	0.48	0.04	0.23	0.03
Sweden	0.32	0.29	0.20	–0.24	–0.07
United Kingdom	0.65	0.53	0.30	0.17	0.14

Appendix C. Exploring the Data

To investigate the issue of overlap in respondents' answers, we present in Table C.1 the data on joint distribution of the two dependent variables used in our study.

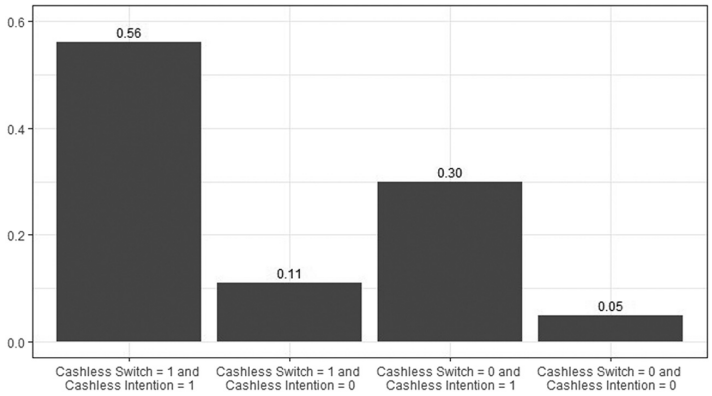
We have also examined whether the summary statistics for each of the four cohorts defined by the cells in the table above are comparable and have discovered the most pronounced differences occur for the variable *Net Fear of Cash*. Figure C.1 plots these values. This

Table C.1. Joint Distribution of the Two Dependent Variables

	Cashless Intention = 0	*Cashless Intention* = 1	Total
Cashless Switch = 0	41.12% (2,263)	12.17% (670)	53.29% (2,933)
Cashless Switch = 1	17.48% (962)	29.23% (1,609)	46.71% (2,571)
Total	58.59% (3,225)	41.41% (2,279)	100.00% (5,504)

Note: This table presents the joint distribution of *Cashless Switch* and *Cashless Intention*. The numbers presented show the proportion of the sample and the number of observations falling within a particular category in parentheses.

Figure C.1. Average *Net Fear of Cash* in Different Cohorts



Note: This figure presents averages for the variable *Net Fear of Cash* in four groups defined by their values of *Cashless Switch* and *Cashless Intention*.

discovery aligns well with the story that is being told in our paper, namely that the fear of COVID transmission through cash drives the payment choices of respondents.

Appendix D

Table D.1. Average Marginal Effects for Control Variables

	Table 4 Column 3	**Table 5 Column 4**
Gender	0.0376	0.0387
Location Size	0.0051	0.0044
Age	0.0011	0.0007
Cards & Mobile	0.1521	0.1259
Anonymity	–0.0160	–0.0034
Convenience of Cashless Payments	0.0005	0.0125
Safety of Cashless Payments	0.0293	0.0549
Access to Cashless Payments Technologies	0.0043	0.0089
Ease of Use of Cashless Technologies	0.0365	0.0440
Control over Finance with Cashless Technologies	0.0041	0.0267
Literacy in Using Mobile Apps	0.0850	0.0346
Experience in Using Computer Payments	0.133	0.0236
Experience in Using Mobile Payments	0.0091	0.0141
COVID Deaths	0.0053	0.0056
Shadow Economy	–0.0026	0.0025
Number of EFT-POS Terminals per Thousand People	0.0005	–0.0002

Note: This table reports average marginal effects for the control variables in logit regressions presented in Table 4 (column 3) and Table 5 (column 3).

Appendix E. Examining the Importance of Historical Cash Usage

In this appendix we attempt to assess the importance of historical cash usage in determining *Cashless Switch* and *Cashless Intention*. Our questionnaire allows us to measure the past use of cash (and by implication cashless instruments), as it includes an item phrased as follows:

Table E.1. Dummy Variables

Variables		No. of Cases
CASH_0	0% of the Payments Made by Cash	363
CASH_30	From 1% to 30% of the Payments Made by Cash	2,901
CASH_60	From 31% to 60% of the Payments Made by Cash	1,217
CASH_99	From 61% to 99% of the Payments Made by Cash	575
CASH_100	100% of the Payments Made by Cash	448

What was the share of individual payment methods in your purchases in physical stores and service outlets in the last 12 months?

[Please specify the shares in the number of transactions, not the value. The selected answers should add up to approximately 100%.]

From the responses recorded, we were able to obtain data on intensity of cash utilization, which was divided into five brackets. These were later transformed into dummy variables, as shown in Table E.1.

Subsequently, these dummies were entered into our logit regressions, while simultaneously excluding the *Cards & Mobile* dummy in order to alleviate any multicollinearity concerns. In a similar vein, one of the dummies (CASH_99) is omitted to circumvent the perfect multicollinearity problem. The results are presented in Tables E.2 and E.3.

Table E.2. Modeling the Switch to Cashless Payments during the Pandemic (including past payment behavior)

	(1)	(2)	(3)
Gender	0.1655**	0.1415*	0.1477*
	(0.0775)	(0.0787)	(0.0790)
Location Size	0.0357	0.0257	0.0284
	(0.0250)	(0.0255)	(0.0257)
Age	0.0039	0.0056**	0.0053**
	(0.0026)	(0.0027)	(0.0027)
Anonymity	–0.0226	–0.0920***	–0.0808**
	(0.0339)	(0.0351)	(0.0352)

(*continued*)

Table E.2. (Continued)

	(1)	(2)	(3)
Convenience of Cashless Payments	–0.0116	–0.0404	–0.0371
	(0.0543)	(0.0565)	(0.0566)
Safety of Cashless Payments	0.0875	0.0891	0.0816
	(0.0608)	(0.0614)	(0.0622)
Access to Cashless Payments Technologies	0.0250	–0.0393	–0.0323
	(0.0536)	(0.0555)	(0.0557)
Ease of Use of Cashless Technologies	0.1551**	0.1739***	0.1650***
	(0.0614)	(0.0626)	(0.0629)
Control over Finance with Cashless Payments	0.0061	–0.0301	–0.0329
	(0.0547)	(0.0553)	(0.0561)
Literacy in Using Mobile Apps	0.3421***	0.3313***	0.3312***
	(0.0479)	(0.0480)	(0.0483)
Experience in Using Computer Payments	0.0755**	0.0333	0.0374
	(0.0373)	(0.0378)	(0.0380)
Experience in Using Mobile Payments	0.0216	0.0004	0.0041
	(0.0453)	(0.0471)	(0.0466)
COVID Deaths	0.0211***	0.0145*	0.0154**
	(0.0073)	(0.0076)	(0.0076)
Shadow Economy	–0.0097*	–0.0154***	–0.0165***
	(0.0059)	(0.0059)	(0.0060)
Number of EFT-POS Terminals per Thousand People	0.0030	0.0004	0.0012
	(0.0025)	(0.0026)	(0.0026)
Net Fear of Cash	0.2615***		0.2232***
	(0.0391)		(0.0398)
Change in Habits Related to Physical Contact		0.4739***	0.4533***
		(0.0428)	(0.0429)
Change in Online Habits		0.0736*	0.0753*
		(0.0400)	(0.0401)
CASH_0	0.6380***	0.5973***	0.5477***
	(0.1903)	(0.1898)	(0.1938)
CASH_30	1.0890***	1.0979***	1.0739***
	(0.1337)	(0.1361)	(0.1370)
CASH_60	0.8344***	0.8203***	0.8308***
	(0.1420)	(0.1453)	(0.1463)
CASH_100	–0.1690	–0.2671	–0.2335
	(0.1891)	(0.1907)	(0.1920)
Constant	–1.3766***	–0.8782***	–0.9617***
	(0.2892)	(0.2980)	(0.2993)
Observations	5,504	5,504	5,504
chi2	415.1	446.6	477.4
p-value	0	0	0
McFadden's Pseudo R-squared	0.109	0.129	0.136

Note: This table reports regression coefficients of weighted logit regressions in which *Cashless Switch* acts as a dependent variable. Variable definitions can be found in Table 2. Robust standard errors are shown in parentheses. ***, **, and * denote statistical significance at 1 percent, 5 percent, and 10 percent, respectively.

Table E.3. Modeling the Intention to Use More Cashless Payments after the Pandemic Is Over (including past payment behavior)

	(1)	(2)	(3)
Gender	0.1780**	0.1435*	0.1578*
	(0.0804)	(0.0849)	(0.0860)
Location Size	0.0322	0.0163	0.0196
	(0.0253)	(0.0273)	(0.0276)
Age	0.0012	0.0039	0.0032
	(0.0027)	(0.0030)	(0.0030)
Anonymity	0.0544	–0.0916**	–0.0770*
	(0.0356)	(0.0395)	(0.0400)
Convenience of Cashless Payments	0.0501	0.0092	0.0129
	(0.0569)	(0.0623)	(0.0631)
Safety of Cashless Payments	0.2231***	0.2458***	0.2436***
	(0.0634)	(0.0699)	(0.0706)
Access to Cashless Payments Technologies	0.0469	–0.0849	–0.0759
	(0.0563)	(0.0652)	(0.0661)
Ease of Use of Cashless Technologies	0.1948***	0.2416***	0.2252***
	(0.0654)	(0.0725)	(0.0740)
Control over Finance with Cashless Payments	0.1198**	0.0545	0.0569
	(0.0565)	(0.0614)	(0.0631)
Literacy in Using Mobile Apps	0.1072**	0.0807	0.0740
	(0.0485)	(0.0524)	(0.0532)
Experience in Using Computer Payments	0.1193***	0.0432	0.0507
	(0.0401)	(0.0423)	(0.0432)
Experience in Using Mobile Payments	0.0293	–0.0063	–0.0005
	(0.0468)	(0.0498)	(0.0499)
COVID Deaths	0.0260***	0.0152*	0.0169**
	(0.0074)	(0.0078)	(0.0078)
Shadow Economy	0.0171***	0.0064	0.0052
	(0.0061)	(0.0065)	(0.0065)
Number of EFT-POS Terminals per Thousand People	0.0005	–0.0047*	–0.0034
	(0.0027)	(0.0028)	(0.0029)
Net Fear of Cash	0.4185***		0.3702***
	(0.0439)		(0.0473)
Change in Habits Related to Physical Contact		1.0197***	0.9985***
		(0.0552)	(0.0557)
Change in Online Habits		0.0772*	0.0800*
		(0.0449)	(0.0460)
CASH_0	1.1021***	1.1036***	1.0491***
	(0.2043)	(0.2210)	(0.2283)
CASH_30	1.2600***	1.3722***	1.3461***
	(0.1492)	(0.1553)	(0.1587)
CASH_60	0.7843***	0.7808***	0.7989***
	(0.1574)	(0.1645)	(0.1676)

(*continued*)

Table E.3. (Continued)

	(1)	(2)	(3)
CASH_100	0.1125	–0.0596	–0.0039
	(0.2048)	(0.2100)	(0.2132)
Constant	–2.4349***	–1.5902***	–1.7295***
	(0.3086)	(0.3249)	(0.3299)
Observations	5,504	5,504	5,504
chi2	503.1	630.1	642.3
p-value	0	0	0
McFadden's Pseudo R-squared	0.146	0.230	0.245

Note: This table reports regression coefficients of weighted logit regressions in which *Cashless Intention* acts as a dependent variable. Variable definitions can be found in Table 2. Robust standard errors are shown in parentheses. ***, **, and * denote statistical significance at 1 percent, 5 percent, and 10 percent, respectively.

Appendix F. Measuring Cashless Payments Attributes Relative to Cash

In the main body of our paper, we have quantified different aspects of cashless payments (convenience, safety, access, ease of use, and control over finance) using factor analysis. This is because we needed to aggregate information on a multitude of payment technologies. The resultant variables were absolute measures, in the sense that they pertained to the cashless technologies alone.

In this appendix we produce regressions where these characteristics are expressed in relative terms. In other words, the attributes of cashless instruments were compared to those of cash. A critical issue that needs to be elucidated here is the procedure that was followed to construct these relative measures. It can be broken into two distinct steps:

(i) For any given payment characteristic (e.g., convenience or safety), we calculate the score differences between each of the six payment instruments (payment cards; HCE payments; Google Pay, Apple Pay, QR, wearables) and cash.

(ii) Factor analysis is then deployed to aggregate the score differences across all payment instruments.

In the regressions that follow (Tables F.1 and F.2), we add the word "Net" in front of a payment characteristic to highlight the fact that it has been calculated relative to cash.

Table F.1. Modeling the Switch to Cashless Payments during the Pandemic (net constructs)

	(1)	(2)	(3)
Gender	0.1776**	0.1483*	0.1558**
	(0.0765)	(0.0776)	(0.0779)
Location Size	0.0287	0.0184	0.0215
	(0.0250)	(0.0255)	(0.0256)
Age	0.0060**	0.0070***	0.0067**
	(0.0025)	(0.0026)	(0.0026)

(*continued*)

Table F.1. (Continued)

	(1)	(2)	(3)
Cards & Mobile	0.6598***	0.7166***	0.7073***
	(0.1310)	(0.1330)	(0.1330)
Anonymity	–0.0174	–0.0943***	–0.0824**
	(0.0341)	(0.0352)	(0.0353)
Net Convenience of Cashless Payments	–0.1688***	–0.1895***	–0.1678***
	(0.0512)	(0.0522)	(0.0527)
Net Safety of Cashless Payments	0.1660***	0.1401**	0.1375**
	(0.0534)	(0.0544)	(0.0549)
Net Access to Cashless Payments Technologies	–0.0117	–0.0935*	–0.0736
	(0.0503)	(0.0506)	(0.0514)
Net Ease of Use of Cashless Technologies	0.0511	0.0448	0.0332
	(0.0565)	(0.0574)	(0.0578)
Net Control over Finance with Cashless Payments	0.0136	–0.0047	–0.0051
	(0.0475)	(0.0484)	(0.0487)
Literacy in Using Mobile Apps	0.3682***	0.3556***	0.3548***
	(0.0468)	(0.0470)	(0.0473)
Experience in Using Computer Payments	0.0688*	0.0249	0.0282
	(0.0357)	(0.0365)	(0.0369)
Experience in Using Mobile Payments	0.0486	0.0204	0.0231
	(0.0438)	(0.0454)	(0.0452)
COVID Deaths	0.0203***	0.0139*	0.0150**
	(0.0072)	(0.0074)	(0.0074)
Shadow Economy	–0.0156***	–0.0229***	–0.0233***
	(0.0058)	(0.0059)	(0.0059)
Number of EFT-POS Terminals per Thousand People	0.0033	0.0008	0.0016
	(0.0025)	(0.0026)	(0.0026)
Net Fear of Cash	0.2708***		0.2308***
	(0.0391)		(0.0399)
Change in Habits Related to Physical Contact		0.4739***	0.4520***
		(0.0421)	(0.0422)
Change in Online Habits		0.0711*	0.0723*
		(0.0397)	(0.0398)
Constant	–1.1584***	–0.6335**	–0.7352**
	(0.2834)	(0.2891)	(0.2913)
Observations	5,504	5,504	5,504
chi2	357.5	406.0	440.7
p-value	0	0	0
McFadden's Pseudo R-squared	0.093	0.112	0.120

Note: This table reports regression coefficients of weighted logit regressions in which *Cashless Switch* acts as a dependent variable. Variable definitions can be found in Table 2. Robust standard errors are shown in parentheses. ***, **, and * denote statistical significance at 1 percent, 5 percent, and 10 percent, respectively.

Table F.2. Modeling the Intention to Use More Cashless Payments after the Pandemic Is Over (net constructs)

	(1)	(2)	(3)
Gender	0.1922**	0.1496*	0.1639*
	(0.0789)	(0.0833)	(0.0844)
Location Size	0.0299	0.0116	0.0162
	(0.0252)	(0.0271)	(0.0272)
Age	0.0038	0.0054*	0.0047
	(0.0027)	(0.0028)	(0.0029)
Cards & Mobile	0.5695***	0.7256***	0.7111***
	(0.1411)	(0.1425)	(0.1427)
Anonymity	0.0727**	–0.0902**	–0.0739*
	(0.0353)	(0.0390)	(0.0393)
Net Convenience of Cashless Payments	–0.3054	–0.3796	–0.3457
	(0.0516)	(0.0585)	(0.0589)
Net Safety of Cashless Payments	0.1512***	0.1051*	0.1066*
	(0.0556)	(0.0604)	(0.0615)
Net Access to Cashless Payments Technologies	–0.0147	–0.1826	–0.1505
	(0.0519)	(0.0562)	(0.0570)
Net Ease of Use of Cashless Technologies	0.1127*	0.1090*	0.0899
	(0.0582)	(0.0635)	(0.0646)
Net Control over Finance with Cashless Payments	0.1176**	0.0937*	0.0985*
	(0.0482)	(0.0544)	(0.0546)
Literacy in Using Mobile Apps	0.1468***	0.1207**	0.1148**
	(0.0478)	(0.0511)	(0.0516)
Experience in Using Computer Payments	0.1442***	0.0639	0.0711*
	(0.0402)	(0.0408)	(0.0426)
Experience in Using Mobile Payments	0.1088**	0.0628	0.0680
	(0.0461)	(0.0473)	(0.0478)
COVID Deaths	0.0223***	0.0113	0.0133*
	(0.0074)	(0.0077)	(0.0078)
Shadow Economy	0.0076	–0.0068	–0.0071
	(0.0059)	(0.0063)	(0.0063)
Number of EFT-POS Terminals per Thousand People	0.0010	–0.0042	–0.0030
	(0.0026)	(0.0028)	(0.0028)
Net Fear of Cash	0.4267***		0.3741***
	(0.0438)		(0.0478)
Change in Habits Related to Physical Contact		1.0339***	1.0110***
		(0.0555)	(0.0559)
Change in Online Habits		0.0736*	0.0759*
		(0.0444)	(0.0453)
Constant	–1.9791***	–1.0295***	–1.1886***
	(0.2908)	(0.3041)	(0.3094)
Observations	5,504	5,504	5,504
chi2	412.0	544.3	553.6
p-value	0	0	0
McFadden's Pseudo R-squared	0.119	0.207	0.223

Note: This table reports regression coefficients of weighted logit regressions in which *Cashless Intention* acts as a dependent variable. Variable definitions can be found in Table 2. Robust standard errors are shown in parentheses. ***, **, and * denote statistical significance at 1 percent, 5 percent, and 10 percent, respectively.

Appendix G

Table G.1. Modeling the Switch to Cashless Payments during the Pandemic (age brackets)

	(1)	(2)	(3)
Gender	0.1722**	0.1488*	0.1548**
	(0.0762)	(0.0773)	(0.0778)
Location Size	0.0247	0.0139	0.0175
	(0.0249)	(0.0253)	(0.0255)
Age < 30	–0.0830	–0.1504	–0.1187
	(0.1649)	(0.1686)	(0.1692)
Age >= 30 and < 40	–0.0949	–0.2115	–0.1697
	(0.1653)	(0.1686)	(0.1696)
Age >= 40 and < 50	0.0953	0.0413	0.0744
	(0.1589)	(0.1624)	(0.1625)
Age >= 50 and < 60	–0.0289	–0.0275	–0.0141
	(0.1604)	(0.1622)	(0.1634)
Age >= 60 and < 70	0.2033	0.0070***	0.0067**
	(0.1547)	(0.0026)	(0.0026)
Cards & Mobile	0.6639***	0.7404***	0.7244***
	(0.1324)	(0.1339)	(0.1340)
Anonymity	–0.0563*	–0.1240***	–0.1094***
	(0.0337)	(0.0348)	(0.0351)
Convenience of Cashless Payments	0.0067	–0.0258	–0.0215
	(0.0537)	(0.0562)	(0.0564)
Safety of Cashless Payments	0.1214**	0.1257**	0.1158*
	(0.0595)	(0.0601)	(0.0607)
Access to Cashless Payments Technologies	0.0228	–0.0447	–0.0376
	(0.0535)	(0.0547)	(0.0552)
Ease of Use of Cashless Technologies	0.1514**	0.1698***	0.1592***
	(0.0600)	(0.0616)	(0.0616)
Control over Finance with Cashless Payments	0.0135	–0.0176	–0.0209
	(0.0529)	(0.0538)	(0.0544)
Literacy in Using Mobile Apps	0.3771***	0.3660***	0.3639***
	(0.0466)	(0.0469)	(0.0472)
Experience in Using Computer Payments	0.0652*	0.0200	0.0253
	(0.0360)	(0.0369)	(0.0372)
Experience in Using Mobile Payments	0.0444	0.0209	0.0230
	(0.0442)	(0.0460)	(0.0458)
COVID Deaths	0.0241***	0.0170**	0.0178**
	(0.0072)	(0.0075)	(0.0075)
Shadow Economy	–0.0139**	–0.0199***	–0.0209***
	(0.0057)	(0.0058)	(0.0059)
Number of EFT-POS Terminals per Thousand People	0.0032	0.0003	0.0013
	(0.0025)	(0.0026)	(0.0026)
Net Fear of Cash	0.2844***		0.2459***
	(0.0390)		(0.0398)
Change in Habits Related to Physical Contact		0.4777***	0.4554***
		(0.0420)	(0.0421)

(*continued*)

Table G.1. (Continued)

	(1)	(2)	(3)
Change in Online Habits		0.0952**	0.0951**
		(0.0394)	(0.0395)
Constant	–0.8453***	–0.2807	–0.4228
	(0.2801)	(0.2852)	(0.2870)
Observations	5,504	5,504	5,504
chi2	350.5	401.6	440.6
p-value	0	0	0
McFadden's Pseudo R-squared	0.0895	0.110	0.118

Note: This table reports regression coefficients of weighted logit regressions in which *Cashless Switch* acts as a dependent variable. Variable definitions can be found in Table 2. Robust standard errors are shown in parentheses. In these models, the dummy for individuals aged 70 and over is excluded and, consequently, this group acts as a benchmark. ***, **, and * denote statistical significance at 1 percent, 5 percent, and 10 percent, respectively.

Table G.2. Modeling the Intention to Use More Cashless Payments after the Pandemic Is Over (age brackets)

	(1)	(2)	(3)
Gender	0.1973**	0.1593*	0.1745**
	(0.0788)	(0.0829)	(0.0843)
Location Size	0.0222	0.0056	0.0103
	(0.0253)	(0.0271)	(0.0273)
Age < 30	–0.1573	–0.2533	–0.1952
	(0.1663)	(0.1794)	(0.1813)
Age >= 30 and < 40	–0.0453	–0.2357	–0.1645
	(0.1622)	(0.1748)	(0.1751)
Age >= 40 and < 50	–0.2829*	–0.3789**	–0.3258*
	(0.1604)	(0.1712)	(0.1720)
Age >= 50 and < 60	–0.3640**	–0.3714**	–0.3543**
	(0.1621)	(0.1732)	(0.1750)
Age >= 60 and < 70	0.0076	–0.0150	0.0387
	(0.1549)	(0.1651)	(0.1668)
Cards & Mobile	0.5699***	0.7454***	0.7224***
	(0.1433)	(0.1430)	(0.1442)
Anonymity	0.0127	–0.1285***	–0.1084***
	(0.0348)	(0.0386)	(0.0393)

(*continued*)

Table G.2. (Continued)

	(1)	(2)	(3)
Convenience of Cashless Payments	0.0701	0.0264	0.0304
	(0.0555)	(0.0615)	(0.0621)
Safety of Cashless Payments	0.2607***	0.2839***	0.2805***
	(0.0633)	(0.0696)	(0.0705)
Access to Cashless Payments Technologies	0.0518	–0.0873	–0.0788
	(0.0571)	(0.0639)	(0.0652)
Ease of Use of Cashless Technologies	0.1919***	0.2355***	0.2165***
	(0.0636)	(0.0707)	(0.0718)
Control over Finance with Cashless Payments	0.1103**	0.0590	0.0598
	(0.0545)	(0.0599)	(0.0615)
Literacy in Using Mobile Apps	0.1522***	0.1263**	0.1177**
	(0.0470)	(0.0511)	(0.0517)
Experience in Using Computer Payments	0.1134***	0.0325	0.0427
	(0.0392)	(0.0408)	(0.0423)
Experience in Using Mobile Payments	0.0615	0.0270	0.0297
	(0.0460)	(0.0480)	(0.0485)
COVID Deaths	0.0286***	0.0172**	0.0190**
	(0.0074)	(0.0077)	(0.0078)
Shadow Economy	0.0105*	–0.0012	–0.0022
	(0.0059)	(0.0062)	(0.0063)
Number of EFT-POS Terminals per Thousand People	0.0006	–0.0048*	–0.0034
	(0.0026)	(0.0028)	(0.0028)
Net Fear of Cash	0.4448***		0.3981***
	(0.0435)		(0.0469)
Change in Habits Related to Physical Contact		1.0052***	0.9827***
		(0.0547)	(0.0551)
Change in Online Habits		0.1127**	0.1150**
		(0.0445)	(0.0456)
Constant	–1.5871***	–0.6104**	–0.8494***
	(0.2807)	(0.2987)	(0.3026)
Observations	5,504	5,504	5,504
chi2	407.0	534.6	552.7
p-value	0	0	0
McFadden's Pseudo R-squared	0.125	0.206	0.225

Note: This table reports regression coefficients of weighted logit regressions in which *Cashless Intention* acts as a dependent variable. Variable definitions can be found in Table 2. Robust standard errors are shown in parentheses. In these models, the dummy for individuals aged 70 and over is excluded and, consequently, this group acts as a benchmark. ***, **, and * denote statistical significance at 1 percent, 5 percent, and 10 percent, respectively.

Appendix H

Table H.1. Modeling the Switch to Cashless Payments during the Pandemic (cash users only)

	(1)	(2)	(3)
Gender	0.1543*	0.1290	0.1361*
	(0.0787)	(0.0797)	(0.0802)
Location Size	0.0217	0.0099	0.0150
	(0.0257)	(0.0262)	(0.0263)
Age	0.0041	0.0061**	0.0056**
	(0.0026)	(0.0027)	(0.0027)
Cards & Mobile	0.6548***	0.7256***	0.7133***
	(0.1359)	(0.1367)	(0.1370)
Anonymity	–0.0832**	–0.1440***	–0.1301***
	(0.0349)	(0.0358)	(0.0361)
Convenience of Cashless Payments	0.0052	–0.0295	–0.0231
	(0.0552)	(0.0576)	(0.0578)
Safety of Cashless Payments	0.0803	0.0953	0.0773
	(0.0618)	(0.0628)	(0.0631)
Access to Cashless Payments Technologies	0.0286	–0.0338	–0.0287
	(0.0554)	(0.0566)	(0.0570)
Ease of Use of Cashless Technologies	0.1697***	0.1865***	0.1780***
	(0.0626)	(0.0640)	(0.0641)
Control over Finance with Cashless Payments	0.0215	–0.0125	–0.0136
	(0.0552)	(0.0560)	(0.0567)
Literacy in Using Mobile Apps	0.3890***	0.3802***	0.3763***
	(0.0489)	(0.0490)	(0.0493)
Experience in Using Computer Payments	0.0469	–0.0013	0.0029
	(0.0369)	(0.0372)	(0.0377)
Experience in Using Mobile Payments	0.0371	0.0133	0.0156
	(0.0452)	(0.0466)	(0.0465)
COVID Deaths	0.0258***	0.0191**	0.0198***
	(0.0073)	(0.0076)	(0.0076)
Shadow Economy	–0.0131**	–0.0191***	–0.0200***
	(0.0058)	(0.0059)	(0.0060)
Number of EFT-POS Terminals per Thousand People	0.0024	–0.0004	0.0006
	(0.0025)	(0.0026)	(0.0026)
Net Fear of Cash	0.2936***		0.2605***
	(0.0408)		(0.0419)
Change in Habits Related to Physical Contact		0.4597***	0.4385***
		(0.0437)	(0.0438)
Change in Online Habits		0.0959**	0.0980**
		(0.0404)	(0.0406)
Constant	–0.9015***	–0.4926*	–0.5932**
	(0.2915)	(0.2969)	(0.2995)
Observations	5,141	5,141	5,141
chi2	323.1	362.8	398.1
p-value	0	0	0
McFadden's Pseudo R-squared	0.089	0.106	0.115

Note: This table reports regression coefficients of weighted logit regressions in which *Cashless Switch* acts as a dependent variable. Variable definitions can be found in Table 2. Robust standard errors are shown in parentheses. ***, **, and * denote statistical significance at 1 percent, 5 percent, and 10 percent, respectively.

Table H.2. Modeling the Intention to Use More Cashless Payments after the Pandemic Is Over (cash users only)

	(1)	(2)	(3)
Gender	0.1886**	0.1461*	0.1627*
	(0.0814)	(0.0860)	(0.0873)
Location Size	0.0212	0.0028	0.0089
	(0.0263)	(0.0281)	(0.0285)
Age	0.0026	0.0059**	0.0050
	(0.0027)	(0.0030)	(0.0030)
Cards & Mobile	0.5979***	0.7745***	0.7606***
	(0.1477)	(0.1442)	(0.1459)
Anonymity	–0.0159	–0.1526***	–0.1351***
	(0.0360)	(0.0397)	(0.0404)
Convenience of Cashless Payments	0.0629	0.0128	0.0198
	(0.0578)	(0.0638)	(0.0647)
Safety of Cashless Payments	0.2651***	0.3123***	0.2968***
	(0.0666)	(0.0732)	(0.0741)
Access to Cashless Payments Technologies	0.0757	–0.0550	–0.0488
	(0.0591)	(0.0666)	(0.0682)
Ease of Use of Cashless Technologies	0.2033***	0.2441***	0.2294***
	(0.0663)	(0.0736)	(0.0750)
Control over Finance with Cashless Payments	0.1091*	0.0468	0.0524
	(0.0569)	(0.0621)	(0.0641)
Literacy in Using Mobile Apps	0.1412***	0.1168**	0.1053**
	(0.0489)	(0.0530)	(0.0536)
Experience in Using Computer Payments	0.1101***	0.0204	0.0287
	(0.0404)	(0.0416)	(0.0436)
Experience in Using Mobile Payments	0.0668	0.0326	0.0358
	(0.0472)	(0.0494)	(0.0500)
COVID Deaths	0.0279***	0.0166**	0.0181**
	(0.0075)	(0.0079)	(0.0079)
Shadow Economy	0.0087	–0.0037	–0.0046
	(0.0061)	(0.0064)	(0.0065)
Number of EFT-POS Terminals per Thousand People	0.0008	–0.0046	–0.0031
	(0.0026)	(0.0028)	(0.0028)
Net Fear of Cash	0.4474***		0.4104***
	(0.0460)		(0.0492)
Change in Habits Related to Physical Contact		1.0185***	1.0005***
		(0.0570)	(0.0577)
Change in Online Habits		0.1126**	0.1181**
		(0.0458)	(0.0473)
Constant	–1.7559***	–1.0091***	–1.1621***
	(0.3007)	(0.3152)	(0.3202)
Observations	5,141	5,141	5,141
chi2	382.7	531.8	539.0
p-value	0	0	0
McFadden's Pseudo R-squared	0.125	0.208	0.227

Note: This table reports regression coefficients of weighted logit regressions in which *Cashless Intention* acts as a dependent variable. Variable definitions can be found in Table 2. Robust standard errors are shown in parentheses. ***, **, and * denote statistical significance at 1 percent, 5 percent, and 10 percent, respectively.

Appendix I. Moderating Effects

In this appendix we investigate whether interaction models could inform us about country-level factors that moderate the relationship between the COVID pandemic and the willingness to switch to cashless payments. Eight different variables are considered as possible moderating factors, which are subsequently interacted in our logistic regressions with *Net Fear of Cash* and the two changes in habits variables. To ease the task of interpretation and alleviate multicollinearity concerns, these eight variables are constructed as dummies that partition our sample into two groups—one in which a given characteristic exists or is prominent (i.e., records an above-median value) and one in which it is not. Three binary indicators were constructed from variables already used in our main analysis, namely *COVID Deaths, Shadow Economy*, and *Number of EFT-POS Terminals per Thousand People*, whereas two additional dummies derive from country scores for power distance and uncertainty avoidance index retrieved from the Hofstede national culture data set. Another two dichotomous variables split the sample into Scandinavian and non-Scandinavian countries, as well as developed versus emerging economies based on the value of GDP per capita in 2020 measured at purchasing power parity prices. The GDP data were sourced from the World Development Indicators database maintained by the World Bank. Finally, we split the countries according to their COVID stringency index, which measures the severity of policy responses to COVID-19 pandemic and was compiled by Mathieu et al. (2020). The values of the stringency index were averaged during the July to August 2020 period, which covers the timeframe when the survey was conducted. Table I.1 catalogues and describes the interaction dummies.

Table I.2 presents logit regressions with interaction terms that model the decision to pay cashless more often during the COVID pandemic.

As there are as many as 24 interaction terms across the eight regressions in the table above, we restrict ourselves to analyzing only those that are statistically significant at the 5 percent level or better. Firstly, the interaction between the Scandinavian country dummy and *Net Fear of Cash* bears a negative coefficient and proves meaningful to the choice of cashless payments during the COVID

Table I.1. Definitions of Variables

Variable	Definition
D_Scand	A dummy variable taking a value of one if the respondent resides in a Scandinavian country and zero otherwise
D_Deaths	A dummy variable taking a value of one if the respondent is from a country with an above-median number of COVID-19 deaths and zero otherwise
D_Shadow	A dummy variable taking a value of one if the respondent's country has an above-median size of the shadow economy (as a percentage of GDP) and zero otherwise
D_Stringency	A dummy variable taking a value of one if the respondent resides in a country with an above-median value of the COVID stringency index and zero otherwise
D_Developed	A dummy variable taking a value of one if the respondent inhabits a country with an above-median value of GDP per capita in international dollars in 2020 and zero otherwise
D_PD	A dummy variable taking a value of one if the respondent is from a country with an above-median value of Hofstede power distance indicator and zero otherwise
D_UA	A dummy variable taking a value of one if the respondent is from a country with an above-median value of Hofstede uncertainty avoidance index and zero otherwise
D_Terminals	A dummy variable taking a value of one if the respondent's country has an above-median number of EFT-POS terminals per thousand people and zero otherwise

epidemic. As is shown in Appendix B, respondents in all of the Scandinavian countries in our sample (Denmark, Finland, Norway, Sweden) showed below-average tendency to change their habits in response to infection risk. Similarly, many of them failed to act out their fears through switching from cash to payment instruments offering a lower risk of virus transmission. Scandinavia had already been characterized by a very high level of electronic payments prior to the COVID outbreak (Armelius, Claussen, and Reslow 2022; Engert, Fung, and Segendorf 2020), which limited the scope of further abandonment of physical currency for transactional purposes. Secondly, the impact of changes in habits in the physical space is lessened for countries with high values of the COVID stringency index. In such countries, changes in behavior may have been primarily driven by the regulations rather than the free will of respondents. Switch to cashless payments, which is entirely voluntary in

Table I.2. Modeling the Switch to Cashless Payments during the Pandemic (including interaction terms)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Gender	0.1616**	0.1627**	0.1536**	0.1642**	0.1585**	0.1636**	0.1563**	0.1558**
	(0.0779)	(0.0779)	(0.0778)	(0.0779)	(0.0779)	(0.0779)	(0.0779)	(0.0778)
Location Size	0.0189	0.0194	0.0185	0.0200	0.0202	0.0193	0.0185	0.0190
	(0.0255)	(0.0255)	(0.0255)	(0.0254)	(0.0255)	(0.0254)	(0.0255)	(0.0256)
Age	0.0063**	0.0063**	0.0063**	0.0062**	0.0062**	0.0061**	0.0063**	0.0065**
	(0.0026)	(0.0026)	(0.0026)	(0.0026)	(0.0026)	(0.0026)	(0.0026)	(0.0026)
Cards & Mobile	0.7320***	0.7251***	0.7337***	0.7256***	0.7240***	0.7295***	0.7311***	0.7360***
	(0.1337)	(0.1332)	(0.1338)	(0.1332)	(0.1337)	(0.1332)	(0.1340)	(0.1338)
Anonymity	–0.1082***	–0.1066***	–0.1084***	–0.1061***	–0.1084***	–0.1068***	–0.1100***	–0.1060***
	(0.0349)	(0.0348)	(0.0348)	(0.0348)	(0.0349)	(0.0348)	(0.0349)	(0.0348)
Convenience of Cashless Payments	–0.0214	–0.0218	–0.0236	–0.0198	–0.0246	–0.0197	–0.0236	–0.0244
	(0.0560)	(0.0560)	(0.0560)	(0.0559)	(0.0561)	(0.0559)	(0.0560)	(0.0560)
Safety of Cashless Payments	0.1133*	0.1174*	0.1152*	0.1190**	0.1135*	0.1205**	0.1115*	0.1155*
	(0.0605)	(0.0605)	(0.0605)	(0.0607)	(0.0605)	(0.0609)	(0.0604)	(0.0607)
Access to Cashless Payments Technologies	–0.0348	–0.0374	–0.0362	–0.0358	–0.0364	–0.0377	–0.0302	–0.0356
	(0.0553)	(0.0551)	(0.0551)	(0.0551)	(0.0552)	(0.0551)	(0.0553)	(0.0551)
Ease of Use of Cashless Technologies	0.1581**	0.1587**	0.1560**	0.1572**	0.1616***	0.1573**	0.1602***	0.1529**
	(0.0618)	(0.0618)	(0.0618)	(0.0618)	(0.0618)	(0.0618)	(0.0618)	(0.0617)
Control over Finance with Cashless Payments	–0.0247	–0.0219	–0.0213	–0.0208	–0.0244	–0.0204	–0.0254	–0.0201
	(0.0544)	(0.0544)	(0.0544)	(0.0544)	(0.0545)	(0.0544)	(0.0546)	(0.0545)
Literacy in Using Mobile Apps	0.3641***	0.3624***	0.3635***	0.3639***	0.3637***	0.3632***	0.3638***	0.3641***
	(0.0473)	(0.0473)	(0.0472)	(0.0474)	(0.0472)	(0.0474)	(0.0471)	(0.0472)
Experience in Using Computer Payments	0.0219	0.0195	0.0206	0.0206	0.0231	0.0224	0.0201	0.0213
	(0.0373)	(0.0372)	(0.0373)	(0.0373)	(0.0373)	(0.0372)	(0.0373)	(0.0371)
Experience in Using Mobile Payments	0.0185	0.0198	0.0164	0.0196	0.0181	0.0192	0.0189	0.0207
	(0.0458)	(0.0459)	(0.0459)	(0.0460)	(0.0460)	(0.0460)	(0.0457)	(0.0459)
COVID Deaths	0.0180**	0.0191**	0.0181**	0.0181**	0.0191**	0.0176**	0.0186**	0.0169**
	(0.0075)	(0.0075)	(0.0075)	(0.0075)	(0.0075)	(0.0076)	(0.0075)	(0.0075)
Shadow Economy	–0.0202***	–0.0201***	–0.0195***	–0.0202***	–0.0210***	–0.0217***	–0.0201***	–0.0203***
	(0.0059)	(0.0058)	(0.0060)	(0.0058)	(0.0059)	(0.0060)	(0.0060)	(0.0059)

(*continued*)

Table I.2. (Continued)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Number of EFT-POS Terminals per Thousand People	0.0011	0.0012	0.0012	0.0014	0.0012	0.0019	0.0013	0.0022
	(0.0026)	(0.0026)	(0.0026)	(0.0025)	(0.0026)	(0.0026)	(0.0026)	(0.0025)
Net Fear of Cash	0.2598***	0.2740***	0.2389***	0.2252***	0.2179***	0.2343***	0.1837**	0.2554***
	(0.0430)	(0.0466)	(0.0500)	(0.0521)	(0.0437)	(0.0567)	(0.0759)	(0.0428)
Change in Habits Related to Physical Contact	0.4489***	0.4283***	0.4889***	0.5459***	0.4407***	0.3894***	0.5221***	0.4971***
	(0.0441)	(0.0498)	(0.0531)	(0.0580)	(0.0454)	(0.0600)	(0.0922)	(0.0464)
Change in Online Habits	0.0977**	0.0798*	0.0745	0.1323**	0.1022**	0.0389*	0.1471*	0.0952**
	(0.0414)	(0.0457)	(0.0474)	(0.0549)	(0.0424)	(0.0337)	(0.0814)	(0.0423)
Net Fear of Cash × D_Scand	–0.2067**							
	(0.0857)							
Change in Habits Related to Physical Contact × D_Scand	0.0604							
	(0.1037)							
Change in Online Habits × D_Scand	–0.0017							
	(0.0849)							
Net Fear of Cash × D_Deaths		–0.1187						
		(0.0892)						
Change in Habits Related to Physical Contact × D_Deaths		0.0777						
		(0.0903)						
Change in Online Habits × D_Deaths		0.0626						
		(0.0816)						
Net Fear of Cash × D_Shadow			0.0230					
			(0.0780)					
Change in Habits Related to Physical Contact × D_Shadow			–0.1201					
			(0.0826)					
Change in Online Habits × D_Shadow			0.0953					
			(0.0758)					
Net Fear of Cash × D_Stringency				0.0343				
				(0.0749)				
Change in Habits Related to Physical Contact *× D_Stringency*				–0.1584**				
				(0.0805)				
Change in Online Habits × D_Stringency				–0.0609				
				(0.0735)				
Net Fear of Cash × D_Developed					0.2248***			
					(0.0726)			
Change in Habits Related to Physical Contact × D_Developed					0.1565*			
					(0.0840)			
Change in Online Habits × D_Developed					–0.0293			
					(0.0740)			
Net Fear of Cash × D_PD						0.0247		
						(0.0762)		

(*continued*)

Table I.2. (Continued)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Change in Habits Related to Physical Contact × D_PD						0.1432*		
						(0.0816)		
Change in Online Habits × D_PD						0.1311*		
						(0.0739)		
Net Fear of Cash × D_UA							0.0838	
							(0.0884)	
Change in Habits Related to Physical Contact × D_UA							–0.0903	
							(0.1028)	
Change in Online Habits × D_UA							–0.0616	
							(0.0904)	
Net Fear of Cash × D_Terminals								–0.0869
								(0.1200)
Change in Habits Related to Physical Contact × D_Terminals								–0.2770***
								(0.1075)
Change in Online Habits × D_Terminals								0.0239
								(0.1062)
Constant	–0.7413**	–0.7634***	–0.7542***	–0.7552***	–0.7347**	–0.7368**	–0.7486**	–0.7822***
	(0.2911)	(0.2902)	(0.2917)	(0.2903)	(0.2908)	(0.2917)	(0.2917)	(0.2911)
Observations	5,504	5,504	5,504	5,504	5,504	5,504	5,504	5,504
chi2	445.9	431.3	434.2	446.5	514.9	448.2	434.8	430.6
p	0	0	0	0	0	0	0	0
r2_p	0.117	0.117	0.117	0.118	0.118	0.118	0.117	0.118

Note: This table reports egression coefficients of weighted logit regressions in which *Cashless Switch* acts as a dependent variable. Variable definitions can be found in Table 2 and in Table I.1. Robust standard errors are shown in parentheses. ***, **, and * denote statistical significance at 1 percent, 5 percent, and 10 percent, respectively.

nature, did not seem to keep up with the regulation-induced behavioral shifts. Thirdly, the variable *Net Fear of Cash* exerted a more prominent impact on decision to abandon cash in countries with high GDP per capita. This is unsurprising since the volume of transactions is expected to be higher for respondents from affluent nations. As more cash transactions are made, the risks are swiftly compounding, and the desire to drift away from cash becomes stronger. This, in turn, explains the statistical significance of the interaction variable. Lastly, the impact of *Change in Habits Related to Physical Contact* on the decision to switch to digital payments is weaker in countries with a large number of EFT-POS terminals per capita.

Table I.3 presents models which include interactive terms and in which the intention to increase the frequency of cashless payments after the pandemic is over acts as a dependent variable.

Two of the interactions in Table I.3 appear to be significant at the 5 percent level. Firstly, the impact of changes in habits in the physical sphere on the declared future intention is stronger in societies with a high power distance. Power distance, as the degree to which hierarchical order is accepted within society, could affect trust in institutions and, consequently, in cashless technologies. If a person feels no resistance towards power distance and is prepared to change their physical habits, transition towards cashless payments will loom large on their agenda due to the relatively high trust in financial institutions. Such rationalization is consistent with the observed positive coefficient on the interaction term. Secondly, the societal uncertainty avoidance also appears to magnify the impact of *Change in Habits Related to Physical Contact* on the future intention to transact more cashless. This means that respondents who were willing to change their physical behavior in response to the dangers posed by COVID and resided in uncertainty-averse nations were particularly eager to abandon cash for transactional purposes.

Table I.3. Modeling the Intention to Use More Cashless Payments after the Pandemic Is Over (including interaction terms)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Gender	0.1768**	0.1821**	0.1772**	0.1820**	0.1765**	0.1856**	0.1809**	0.1729**
	(0.0843)	(0.0842)	(0.0843)	(0.0842)	(0.0844)	(0.0842)	(0.0844)	(0.0842)
Location Size	0.0133	0.0131	0.0134	0.0138	0.0133	0.0131	0.0136	0.0129
	(0.0272)	(0.0272)	(0.0273)	(0.0272)	(0.0273)	(0.0272)	(0.0272)	(0.0273)
Age	0.0046	0.0047	0.0048	0.0046	0.0047	0.0045	0.0044	0.0047
	(0.0029)	(0.0029)	(0.0029)	(0.0029)	(0.0029)	(0.0029)	(0.0029)	(0.0029)
Cards & Mobile	0.7325***	0.7322***	0.7336***	0.7257***	0.7298***	0.7340***	0.7398***	0.7378***
	(0.1440)	(0.1440)	(0.1440)	(0.1436)	(0.1439)	(0.1440)	(0.1452)	(0.1443)
Anonymity	–0.1124***	–0.1094***	–0.1127***	–0.1107***	–0.1132***	–0.1085***	–0.1108***	–0.1113***
	(0.0391)	(0.0390)	(0.00391)	(0.0391)	(0.0391)	(0.0391)	(0.0391)	(0.0389)
Convenience of Cashless Payments	0.0290	0.0297	0.0272	0.0311	0.0269	0.0335	0.0346	0.0260
	(0.0620)	(0.0622)	(0.0620)	(0.0621)	(0.0621)	(0.0621)	(0.0622)	(0.0620)
Safety of Cashless Payments	0.2709***	0.2758***	0.2725***	0.2743***	0.2716***	0.2747***	0.2715***	0.2730***
	(0.0700)	(0.0701)	(0.0702)	(0.0699)	(0.0701)	(0.0701)	(0.0695)	(0.0701)
Access to Cashless Payments Technologies	–0.0788	–0.0777	–0.0778	–0.0757	–0.0795	–0.0768	–0.0776	–0.0785
	(0.0652)	(0.0650)	(0.0651)	(0.0650)	(0.0652)	(0.0650)	(0.0653)	(0.0651)
Ease of Use of Cashless Technologies	0.2135***	0.2118***	0.2122***	0.2127***	0.2144***	0.2121***	0.2166***	0.2085***
	(0.0718)	(0.0719)	(0.0718)	(0.0717)	(0.0718)	(0.0717)	(0.0718)	(0.0716)
Control over Finance with Cashless Payments	0.0711	0.0768	0.0712	0.0740	0.0715	0.0761	0.0682	0.0739
	(0.0609)	(0.0608)	(0.0608)	(0.0607)	(0.0609)	(0.0607)	(0.0606)	(0.0608)
Literacy in Using Mobile Apps	0.1197**	0.1197**	0.1194**	0.1210**	0.1196**	0.1209**	0.1166**	0.1202**
	(0.0515)	(0.0516)	(0.0514)	(0.0516)	(0.0514)	(0.0516)	(0.0513)	(0.0515)
Experience in Using Computer Payments	0.0469	0.0440	0.0463	0.0448	0.0471	0.0456	0.0505	0.0467
	(0.0427)	(0.0427)	(0.0426)	(0.0426)	(0.0426)	(0.0424)	(0.0427)	(0.0426)
Experience in Using Mobile Payments	0.0345	0.0326	0.0364	0.0336	0.0349	0.0340	0.0393	0.0359
	(0.0485)	(0.0488)	(0.0485)	(0.0488)	(0.0486)	(0.0489)	(0.0485)	(0.0487)
COVID Deaths	0.0185**	0.0177**	0.0183**	0.0177**	0.0190**	0.0163**	0.0184**	0.0171**
	(0.0078)	(0.0081)	(0.0078)	(0.0078)	(0.0078)	(0.0080)	(0.0078)	(0.0078)
Shadow Economy	–0.0022	–0.0019	–0.0014	–0.0018	–0.0026	–0.0039	–0.0026	–0.0018
	(0.0063)	(0.0063)	(0.0066)	(0.0063)	(0.0063)	(0.0065)	(0.0065)	(0.0063)
Number of EFT-POS Terminals per Thousand People	–0.0036	–0.0034	–0.0035	–0.0034	–0.0036	–0.0027	–0.0036	–0.0020
	(0.0028)	(0.0028)	(0.0028)	(0.0028)	(0.0028)	(0.0028)	(0.0028)	(0.0028)
Net Fear of Cash	0.4024***	0.4252***	0.3958***	0.3473***	0.3791***	0.4081***	0.4475***	0.4111***
	(0.0509)	(0.0552)	(0.0597)	(0.0591)	(0.0523)	(0.0691)	(0.0894)	(0.0505)

(*continued*)

Table I.3. (Continued)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Change in Habits Related to Physical Contact	0.9850***	0.9207***	1.0027***	1.0920***	0.9892***	0.8713***	0.7927***	1.0271***
	(0.0579)	(0.0639)	(0.0697)	(0.0722)	(0.0600)	(0.0771)	(0.1125)	(0.0609)
Change in Online Habits	0.1147**	0.1100**	0.1205**	0.0797	0.1145**	0.1309**	0.2220**	0.1049**
	(0.0475)	(0.0519)	(0.0548)	(0.0618)	(0.0489)	(0.0619)	(0.0917)	(0.0485)
Net Fear of Cash × D_Scand	–0.0902							
	(0.0926)							
Change in Habits Related to Physical Contact × D_Scand	–0.0089							
	(0.1250)							
Change in Online Habits × D_Scand	–0.0875							
	(0.0965)							
Net Fear of Cash × D_Deaths		–0.1036						
		(0.1037)						
Change in Habits Related to Physical Contact × D_Deaths		0.2193*						
		(0.1164)						
Change in Online Habits × D_Deaths		–0.0008						
		(0.0929)						
Net Fear of Cash × D_Shadow			–0.0005					
			(0.0918)					
Change in Habits Related to Physical Contact × D_Shadow			–0.0622					
			(0.1067)					
Change in Online Habits × D_Shadow			–0.0404					
			(0.0861)					
Net Fear of Cash × D_Stringency				0.0876				
				(0.0880)				
Change in Habits Related to Physical Contact × D_Stringency				–0.1827*				
				(0.1007)				
Change in Online Habits × D_Stringency				0.0501				
				(0.0831)				
Net Fear of Cash × D_Developed					0.1346*			
					(0.0815)			
Change in Habits Related to Physical Contact × D_Developed					–0.0330			
					(0.0996)			
Change in Online Habits × D_Developed					–0.0442			
					(0.0823)			
Net Fear of Cash × D_PD						–0.0228		
						(0.0898)		

(*continued*)

Table I.3. (Continued)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Change in Habits Related to Physical Contact × D_PD						0.2526**		
						(0.1036)		
Change in Online Habits × D_PD						–0.0494		
						(0.0834)		
Net Fear of Cash × D_UA							–0.0760	
							(0.1038)	
Change in Habits Related to Physical Contact × D_UA							0.2548**	
							(0.1278)	
Change in Online Habits × D_UA							–0.1479	
							(0.1022)	
Net Fear of Cash × D_Terminals								–0.1018
								(0.1404)
Change in Habits Related to Physical Contact × D_Terminals								–0.2499*
								(0.1340)
Change in Online Habits × D_Terminals								0.0289
								(0.1226)
Constant	–1.2376***	–1.2580***	–1.2612***	–1.2472***	–1.2340***	–1.2292***	–1.2389***	–1.2904***
	(0.3119)	(0.3112)	(0.3142)	(0.3113)	(0.3115)	(0.3137)	(0.3132)	(0.3123)
Observations	5,504	5,504	5,504	5,504	5,504	5,504	5,504	5,504
chi2	597.5	563.9	567.9	608.9	663.7	616.1	561.1	546.2
p	0	0	0	0	0	0	0	0
r2_p	0.223	0.224	0.223	0.224	0.223	0.225	0.225	0.224

Note: This table reports egression coefficients of weighted logit regressions in which *Cashless Intention* acts as a dependent variable. Variable definitions can be found in Table 2 and in Table I.1. Robust standard errors are shown in parentheses. ***, **, and * denote statistical significance at 1 percent, 5 percent, and 10 percent, respectively.

Appendix J

Table J.1. Modeling the Switch to Cashless Payments during the Pandemic (probit estimates)

	(1)	(2)	(3)
Gender	0.1054**	0.0906*	0.0952**
	(0.0465)	(0.0470)	(0.0472)
Location Size	0.0164	0.0091	0.0111
	(0.0151)	(0.0153)	(0.0154)
Age	0.0029*	0.0039**	0.0038**
	(0.0015)	(0.0016)	(0.0016)
Cards & Mobile	0.4067***	0.4529***	0.4450***
	(0.0782)	(0.0789)	(0.0788)
Anonymity	–0.0346*	–0.0760***	–0.0671***
	(0.0205)	(0.0210)	(0.0211)
Convenience of Cashless Payments	0.0043	–0.0169	–0.0140
	(0.0328)	(0.0339)	(0.0339)
Safety of Cashless Payments	0.0719**	0.0748**	0.0678*
	(0.0363)	(0.0364)	(0.0366)
Access to Cashless Payments Technologies	0.0138	–0.0234	–0.0201
	(0.0326)	(0.0332)	(0.0334)
Ease of Use of Cashless Technologies	0.0933**	0.1008***	0.0953**
	(0.0367)	(0.0373)	(0.0374)
Control over Finance with Cashless Payments	0.0078	–0.0117	–0.0134
	(0.0324)	(0.0328)	(0.0331)
Literacy in Using Mobile Apps	0.2323***	0.2248***	0.2233***
	(0.0285)	(0.0286)	(0.0287)
Experience in Using Computer Payments	0.0397*	0.0110	0.0140
	(0.0219)	(0.0220)	(0.0222)
Experience in Using Mobile Payments	0.0253	0.0082	0.0101
	(0.0271)	(0.0280)	(0.0278)
COVID Deaths	0.0150***	0.0108**	0.0112**
	(0.0044)	(0.0045)	(0.0045)
Shadow Economy	–0.0081**	–0.0117***	–0.0122***
	(0.0035)	(0.0035)	(0.0035)
Number of EFT-POS Terminals per Thousand People	0.0019	0.0001	0.0006
	(0.0015)	(0.0015)	(0.0016)
Net Fear of Cash	0.1718***		0.1495***
	(0.0233)		(0.0237)
Change in Habits Related to Physical Contact		0.2877***	0.2749***
		(0.0249)	(0.0250)
Change in Online Habits		0.0599**	0.0601**
		(0.0239)	(0.0240)
Constant	–0.6550***	–0.3842**	–0.4484**
	(0.1705)	(0.1742)	(0.1748)
Observations	5,504	5,504	5,504
chi2	374.5	433.7	479.1
p-value	0	0	0
McFadden's Pseudo R-squared	0.0887	0.109	0.117

Note: This table reports regression coefficients of weighted logit regressions in which *Cashless Switch* acts as a dependent variable. Variable definitions can be found in Table 2. Robust standard errors are shown in parentheses. ***, **, and * denote statistical significance at 1 percent, 5 percent, and 10 percent, respectively.

Table J.2. Modeling the Intention to Use More Cashless Payments after the Pandemic Is Over (probit estimates)

	(1)	(2)	(3)
Gender	0.1136**	0.0895*	0.0966*
	(0.0475)	(0.0495)	(0.0501)
Location Size	0.0164	0.0040	0.0072
	(0.0153)	(0.0161)	(0.0162)
Age	0.0015	0.0030*	0.0025
	(0.0016)	(0.0017)	(0.0017)
Cards & Mobile	0.3277***	0.4430***	0.4256***
	(0.0831)	(0.0845)	(0.0847)
Anonymity	0.0059	–0.0789***	–0.0680***
	(0.0210)	(0.0227)	(0.0230)
Convenience of Cashless Payments	0.0405	0.0145	0.0151
	(0.0336)	(0.0360)	(0.0364)
Safety of Cashless Payments	0.1437***	0.1588***	0.1520***
	(0.0375)	(0.0405)	(0.0407)
Access to Cashless Payments Technologies	0.0306	–0.0457	–0.0384
	(0.0339)	(0.0373)	(0.0379)
Ease of Use of Cashless Technologies	0.1110***	0.1365***	0.1277***
	(0.0382)	(0.0413)	(0.0418)
Control over Finance with Cashless Payments	0.0729**	0.0353	0.0341
	(0.0329)	(0.0354)	(0.0360)
Literacy in Using Mobile Apps	0.0958***	0.0797***	0.0757***
	(0.0286)	(0.0302)	(0.0305)
Experience in Using Computer Payments	0.0737***	0.0225	0.0290
	(0.0233)	(0.0240)	(0.0245)
Experience in Using Mobile Payments	0.0444	0.0193	0.0224
	(0.0278)	(0.0287)	(0.0288)
COVID Deaths	0.0173***	0.0097**	0.0107**
	(0.0045)	(0.0046)	(0.0046)
Shadow Economy	0.0065*	–0.0010	–0.0012
	(0.0036)	(0.0037)	(0.0037)
Number of EFT-POS Terminals per Thousand People	0.0004	–0.0029*	–0.0021
	(0.0015)	(0.0016)	(0.0016)
Net Fear of Cash	0.2617***		0.2273***
	(0.0253)		(0.0270)
Change in Habits Related to Physical Contact		0.5853***	0.5690***
		(0.0304)	(0.0307)
Change in Online Habits		0.0605**	0.0614**
		(0.0258)	(0.0262)
Constant	–1.0988***	–0.6081***	–0.6986***
	(0.1734)	(0.1804)	(0.1830)
Observations	5,504	5,504	5,504
chi2	436.8	587.3	609.2
p-value	0	0	0
McFadden's Pseudo R-squared	0.122	0.203	0.221

Note: This table reports regression coefficients of weighted logit regressions in which *Cashless Intention* acts as a dependent variable. Variable definitions can be found in Table 2. Robust standard errors are shown in parentheses. ***, **, and * denote statistical significance at 1 percent, 5 percent, and 10 percent, respectively.

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P2:
COVID-19 pandemic increases the divide between cash and cashless payment users in Europe

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COVID-19 pandemic increases the divide between cash and cashless payment users in Europe

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ABSTRACT

This paper investigates how the COVID-19 pandemic has changed an important aspect of everyday life, viz. how people make payments. The empirical study is based on a survey of over 5000 respondents from 22 European countries. It shows that consumers who had been making cashless payments prior to the outbreak of the pandemic have been even more likely to do so since it broke out. On the other hand, the consumers who had mostly been paying in cash have often continued to do so. The divide between those who pay in cash and those who do not, therefore, seems to have widened during the pandemic. It may suggest financial inclusion issues. Additionally, we found that the probability of more frequent cashless payments as a result of the pandemic differs considerably between countries and therefore indicate the role of country-specific factors.

1. Introduction

Consumer payment behaviour is important for the real economy and the efficiency of the payment system (Humphrey et al., 2006; Zhang et al., 2019). The ways in which payments are made depends on a plethora of factors (see e.g. Arango-Arango et al., 2018; Bagnall et al., 2016; Koulayev et al., 2016; Liñares-Zegarra and Willesson, 2021; van der Cruijsen and van der Horst, 2019), and changes tend to be incremental (see e.g. ECB (2020) and Greene and Stavins (2020) for developments in Europe and the United States respectively). However, the COVID-19 pandemic (henceforth "the pandemic"), and the measures imposed by governments to contain it, appear to have had a considerable impact on consumer payment behaviour. This is most evident in the rapid increase in the adoption of cashless payments.

By drawing on the data from various national payment systems, Kraenzlin et al. (2020), Ardizzi et al. (2020) and Bounie et al. (2020) show that the volume of cashless payments increased in Switzerland, Italy and France during the pandemic, despite an overall decline in consumption expenditure. A payment diary survey conduct in the Netherlands by Jonker et al. (2020) shows an increase in debit card use since the onset of the pandemic. However, this growth is mainly attributable to government restrictions imposed to contain the pandemic. Wisniewski et al. (2021) show that the decrease in cash transactions was due to both fear (of getting infections in connection with the use of cash) and new habits developed during enforced safety measures.

This study primarily aims to investigate how the use of cash prior to the outbreak of the pandemic have influenced consumer payment behaviour during it. It additionally examines the extent to which the specificities of particular countries have affected behavioural changes in payment patterns. The paper is structured as follows: Section 2 presents the data and discusses the methodology; Section 3 presents the empirical results, and Section 4 concludes our findings.

2. Data and method

Our analysis is based on a stratified random CAWI survey of 5504 respondents—with age, gender, and size of the respondent's locality stratification factors—conducted in 22 European countries between July and August 2020.[1] Table 1 presents details on the variables used in the study and Table 2 contains their descriptive statistics.

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[1] The respondents resided in 20 European Union member states (Croatia, Cyprus, Estonia, Latvia, Luxembourg, Malta, and Slovenia were omitted), the United Kingdom, and Norway.

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Table 1
Variable definition.

Variable	Definition
Payment_behaviour_change	One of five possible answers to the question "Has the coronavirus pandemic (COVID-19) affected how you pay in physical stores?" These are: 1 – Yes, I pay more often cashless (by card, smartphone, smartwatch); 2 – Yes, I pay more often in cash; 3 – I pay the same way as I did before the pandemic; 4 – I do not know; 5 – I did not make any purchases during the pandemic.
Payment_behaviour_change_ordered	Ordered *payment_behaviour_change* variable with the following values assigned: 1 – for answer 1 (change towards cashless payments); 0 – for answer 3 (no change); −1 – for answer 2 (change towards cash payments).
Cash_usage	Self-reported share of cash transactions in retail payments at physical points-of-sale in the 12 months preceding the COVID-19 pandemic outbreak.
Gender	Dummy variable indicating whether the respondent is male (1) or not (0).
Age	Respondent's age in years.
Location_size	The size of the place of residence of the respondent. Responses are coded on a 6-point scale: 1 – Rural area; 2 – City with a population of less than 50,000; 3 – City with a population of between 50,000 and 100,000; 4 – City with a population of between 100,000 and 500,000; 5 – City with a population of between 500,000 and 1,000,000; 6 – City with a population of over 1,000,000.
Education_years	Respondent's years of formal education.
Income_below_average	Dummy variable indicating whether the respondent's income was below average in his country of residence (1 = yes, 0 = no).
Mobile_bank	Dummy variable indicating whether the respondent had used a mobile banking application in the 12 months prior to the survey (1 = yes, 0 = no).
Mobile_payments	Dummy variable indicating whether the respondent had used a mobile payment application (Google Pay, Apple Pay, Samsung Pay, HCE) in the 12 months prior to the survey (1 = yes, 0 = no).
Wearables_payments	Dummy variable indicating whether the respondent had used contactless payment-enabled wearables (smartwatches, smartbands and systems, e.g., Garmin Pay, Huawei Pay) in the 12 months prior to the survey (1 = yes, 0 = no).
Social_networks	Dummy variable indicating whether the respondent had a profile on a social media platform (Facebook, Instagram, etc.) (1 = yes, 0 = no).

Table 2
Descriptive statistics.

Variable	Mean	SD	Min	Median	Max
Payment_behaviour_change_ordered	0.41132	0.61366	−1.00000	0.00000	1.00000
Cash_usage	0.32716	0.30219	0.00000	0.22766	1.00000
Gender	0.48074	0.49968	0.00000	0.00000	1.00000
Age	47.12581	16.25443	18.00000	47.00000	98.00000
Location_size	2.77517	1.57503	1.00000	2.00000	6.00000
Education_years	13.85446	3.40651	0.00000	14.00000	25.00000
Income_below_average	0.12842	0.33459	0.00000	0.00000	1.00000
Mobile_bank	0.55444	0.49707	0.00000	1.00000	1.00000
Mobile_payments	0.28141	0.44973	0.00000	0.00000	1.00000
Wearables_payments	0.12730	0.33334	0.00000	0.00000	1.00000
Social_networks	0.80644	0.39513	0.00000	1.00000	1.00000

Note: The variables are defined in Table 1. The number of observations for each of the variables listed above is 5,373.

Our dependent variable (*Payment_behaviour_change)* is based on the response to the question "Has the coronavirus pandemic (COVID-19) affected how you pay in physical stores?", which had five possible answers. Respondents who could not answer the question or who stated that they did not make any purchase during the pandemic were excluded from further investigation. This left 5373 respondents and three answers, that were ordered and the following values assigned to them:

1 — the respondent paid cashless more frequently;
0 — the respondent's payment behaviour had not changed;
−1 — the respondent paid in cash more frequently.

Generally, 47.9% of the sample indicated a move towards more cashless payments, whereas 6.7% reported a move towards cash payments. 45.4% of respondents did not change their payment behaviour. It should be noted, however, that the responses varied widely between countries (see Table 3).

Our main explanatory variable is the self-reported share of cash transactions at physical points-of-sale in the 12 months preceding the pandemic outbreak (*Cash_usage*). We allow for a non-linear relationship between the initial share of transactions done by cash and the respective outcomes by adding the squared values of the former. Various control variables obtained in the survey are also used.

Dummy variables have additionally been included for each country (*Country_dummies*). These are used to cover unobserved

Table 3
Declared change in payment behaviour during COVID-19 pandemic.

Country	Share		
	1	0	-1
Austria	40.9%	52.1%	7.0%
Belgium	64.6%	27.2%	8.2%
Bulgaria	30.1%	59.2%	10.7%
Czechia	43.3%	53.3%	3.3%
Denmark	43.0%	50.3%	6.7%
Finland	41.2%	53.8%	5.0%
France	43.1%	48.7%	8.2%
Germany	34.7%	48.8%	16.5%
Greece	48.0%	46.6%	5.4%
Hungary	35.2%	62.1%	2.8%
Ireland	64.4%	25.3%	10.3%
Italy	40.3%	48.8%	10.8%
Lithuania	31.7%	62.1%	6.2%
Netherlands	56.7%	35.6%	7.7%
Poland	56.9%	40.3%	2.8%
Portugal	62.3%	34.2%	3.4%
Romania	56.6%	34.5%	9.0%
Slovakia	40.1%	55.1%	4.8%
Spain	50.2%	44.0%	5.8%
Sweden	33.5%	60.7%	5.9%
United Kingdom	68.4%	26.0%	5.6%
Norway	47.7%	48.7%	3.6%
average	47.9%	45.4%	6.7%

Note: The total number of observations is 5,373; 1 denotes a change towards cashless payments, 0 no change declared, and −1 a change towards cash payments.

or omitted factors.[2] We allow for further differences between countries by adding interaction terms between country dummies and both the cash usage prior to the outbreak of the pandemic (*Cash_usage*) and its square (in addition to the *Country_dummies* themselves).

Ordered logistic regression is used to estimate the relationship between the dependent variable and the explanatory variables. Four models are used to ensure robustness. The parameters of the first model are estimated with the main explanatory variable and basic socio-demographic controls. The second model expands on the first by adding control variables related to various banking and payment innovations and the use of social media. The third model adds dummy variables for each country, and the fourth includes the interaction terms. The full model takes the following form:

$$y_i^* = \alpha_1 * \text{cash\_usage}_i + \alpha_2 * \text{cash\_usage}_i^2 + \sum_{j=1}^{n-1} \alpha_{3j} * \textit{country}\ \text{j}_i + \sum_{j=1}^{n-1} \alpha_{4j} * \textit{country}\ \text{j}_i * \text{cash\_usage}_i + \sum_{j=1}^{n-1} \alpha_{5j} * \textit{country}\ \text{j}_i * \text{cash\_usage}_i^2 + \alpha_6 * Z_i + \mu_i \quad (1)$$

where: i identifies the observations (respondents); j identifies the country; n is the number of countries; Z are the control variables; α are the parameters; μ is the random component with a logistic distribution; and y^* is an unobservable continuous variable which can be mapped onto the observed, ordinal variable y.

[2] E.g. different levels of adoption of cashless payment instruments or development of payment infrastructure (Russo, 2021), nation-specific payment behaviour (ECB, 2020), or the severity of the COVID-19 crisis and the policy responses to it (Ritchie et al., 2020).

3. Results and discussion

Fig. 1 presents the distributions of the answers for our dependent variable in a cross with *Cash_usage* (our main explanatory variable). Interestingly, it suggests that the respondents who usually paid in cash before the outbreak of the pandemic have often continued to do so, whereas those who usually made cashless payments now do so more frequently.

Table 4 presents the results of our models. The frequency of cash usage prior to the outbreak of the pandemic, our main explanatory variable, is significant, albeit in squared terms. However, results associated with this variable are not directly interpretable due to applied interaction terms. Still, the rest of the results show, that respondents that use innovative banking and payment solutions and with the increase of years of formal education the probability of change toward cashless payments is rising. However, below-average income and maleness increase the probability of different outcomes: lack of payment behaviour change or more frequent use of cash. Neither the size of the respondent's place of residence nor social network usage seems to have significantly affected payment behaviour during the pandemic.

Fig. 2 presents the calculated probabilities of making more cashless payments in response to the pandemic in different countries for various initial proportions of cash payments. The probability of change is generally negatively related to the share of cash transactions prior to the outbreak of the pandemic. However, there are notable exceptions. For example, in Belgium, Czechia, Romania, and Spain, the probability curves have a negative parabolic shape whose vertices (i.e. where the probability is greatest) correspond to an initial cash share of 25%–50%. On the other hand, the probabilities for the Netherlands and Norway exhibit an inverted relationship. Most notably, Norway is the only country in which (after a slight decline) the probability of making more cashless payments increases with the initial share of cash payments.

4. Conclusions and future studies

This paper sheds more light on the change of payment behaviour since the onset of the pandemic. Our results lead to two main conclusions.

Firstly, consumers who had been making cashless payments prior to the outbreak of the pandemic have often been doing so more frequently since, while those who had preferred to pay in cash have for the most part continued to do so. This may indicate financial inclusion issues—e.g. people without cashless instruments could have difficulties to adapt to the new situation within the bounds of imposed restrictions. It should be noted, however, that although Wisniewski et al. (2021) showed that (among other factors) change of shopping behaviour and fear of using cash due to the COVID affected both payment behaviour during the pandemic and intentions of further use of cashless payments after the pandemic, it is not obvious whether those changes will last. This could be an interesting topic for future studies.

Secondly, the change in payment patterns in response to the pandemic varies between the European countries. This suggests the significant role of country-specific factors. Further studies could potentially include research on those factors, among them: the role of various levels of adoption of payment methods or the development of payment infrastructure, size of the shadow economy, cultural differences, and the impact of the pandemic on consumers in different countries.

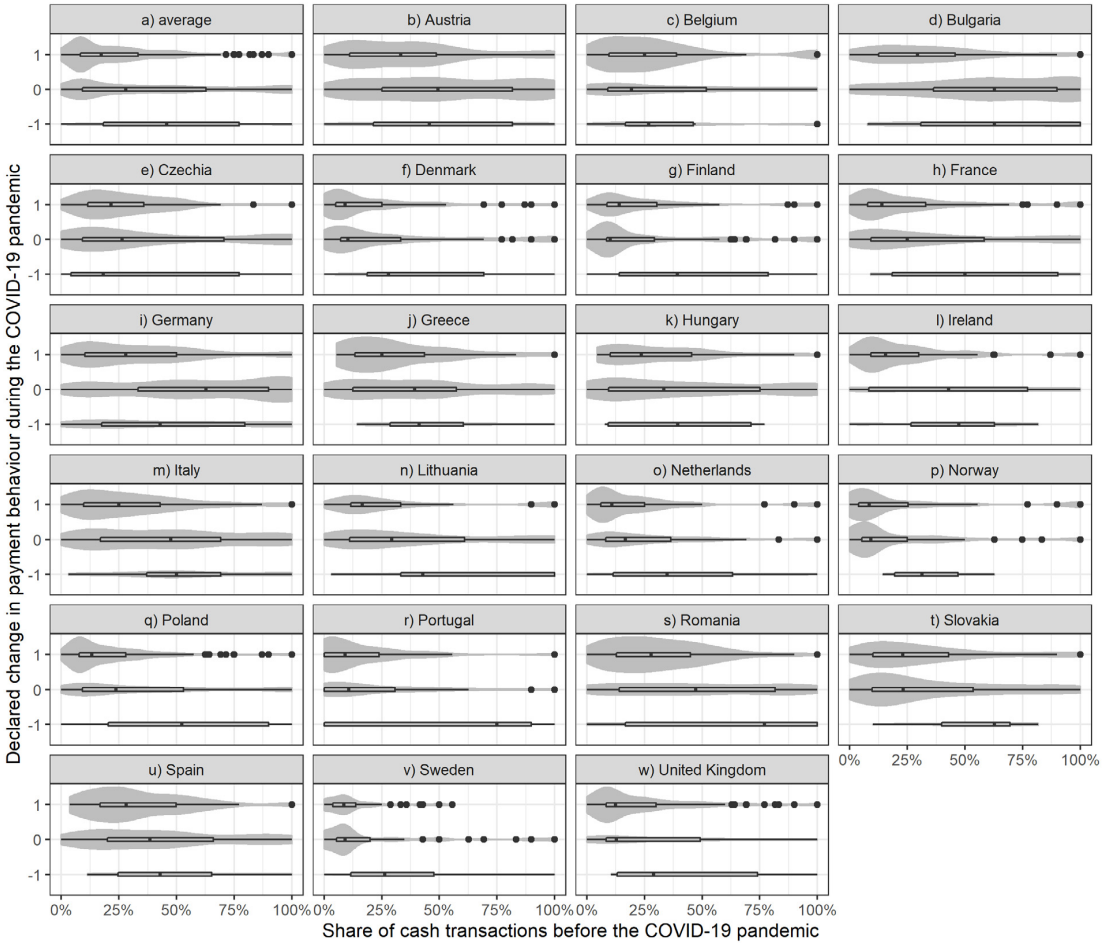

Fig. 1. Change in payment behaviour during the pandemic in relation to respondents share of cash transactions before the pandemic in different countries.
Note: The total number of observations is 5373. 1 denotes a change towards cashless payments, 0 no change declared, and −1 a change towards cash payments.

Table 4
Estimation output. Dependent variable *Payment_behaviour_change_ordered*.

	(1)	(2)	(3)	(4)
Cash_usage	−0.5929*	−0.1187	−0.1573	−0.3073
	(0.3257)	(0.3319)	(0.3500)	(1.5958)
Cash_usage-squared	−1.0544***	−1.2527***	−1.1527***	−0.9178
	(0.3274)	(0.3305)	(0.3415)	(1.4888)
Gender	−0.1745***	−0.2217***	−0.2325***	−0.2320***
	(0.0550)	(0.0560)	(0.0566)	(0.0572)
Age	−0.0045***	0.0015	0.0015	0.0014
	(0.0017)	(0.0018)	(0.0019)	(0.0019)
Location_size	0.0263	0.0124	0.0121	0.0133
	(0.0174)	(0.0176)	(0.0182)	(0.0184)
Education_years	0.0350***	0.0326***	0.0311***	0.0305***
	(0.0081)	(0.0081)	(0.0084)	(0.0084)
Income_below_average	−0.4586***	−0.4259***	−0.3598***	−0.3684
	(0.0827)	(0.0833)	(0.0855)	(0.0865)
Mobile_bank		0.2864***	0.2808***	0.2835***
		(0.0611)	(0.0622)	(0.0629)
Mobile_payments		0.2469***	0.2102***	0.0622**
		(0.0714)	(0.0734)	(0.0750)
Wearables_payments		0.5712***	0.5411***	0.1810***
		(0.0947)	(0.0965)	(0.0742)
Social_networks		0.0776	0.0630	0.5383
		(0.0720)	(0.0744)	(0.0973)

(*continued on next page*)

Table 4 (*continued*).

	(1)	(2)	(3)	(4)
Country_dummies	No	No	Yes	Yes
Country_interactions	No	No	No	Yes
Observations	5373	5373	5373	5373
Pseudo R-squared	0.0473	0.0581	0.0740	0.0823

Note: Variable definitions can be found in Table 1. In model 4, due to the introduction of *Country_interactions*, parameters on *Cash_usage* and *Cash_usage*-squared are interpreted as an effect for the base country. The table presents ordered log-odds (logit) regression coefficients with standard errors shown in parentheses.
***Denote statistical significance at 1%.
**Denote statistical significance at 5%.
*Denote statistical significance at 10%.

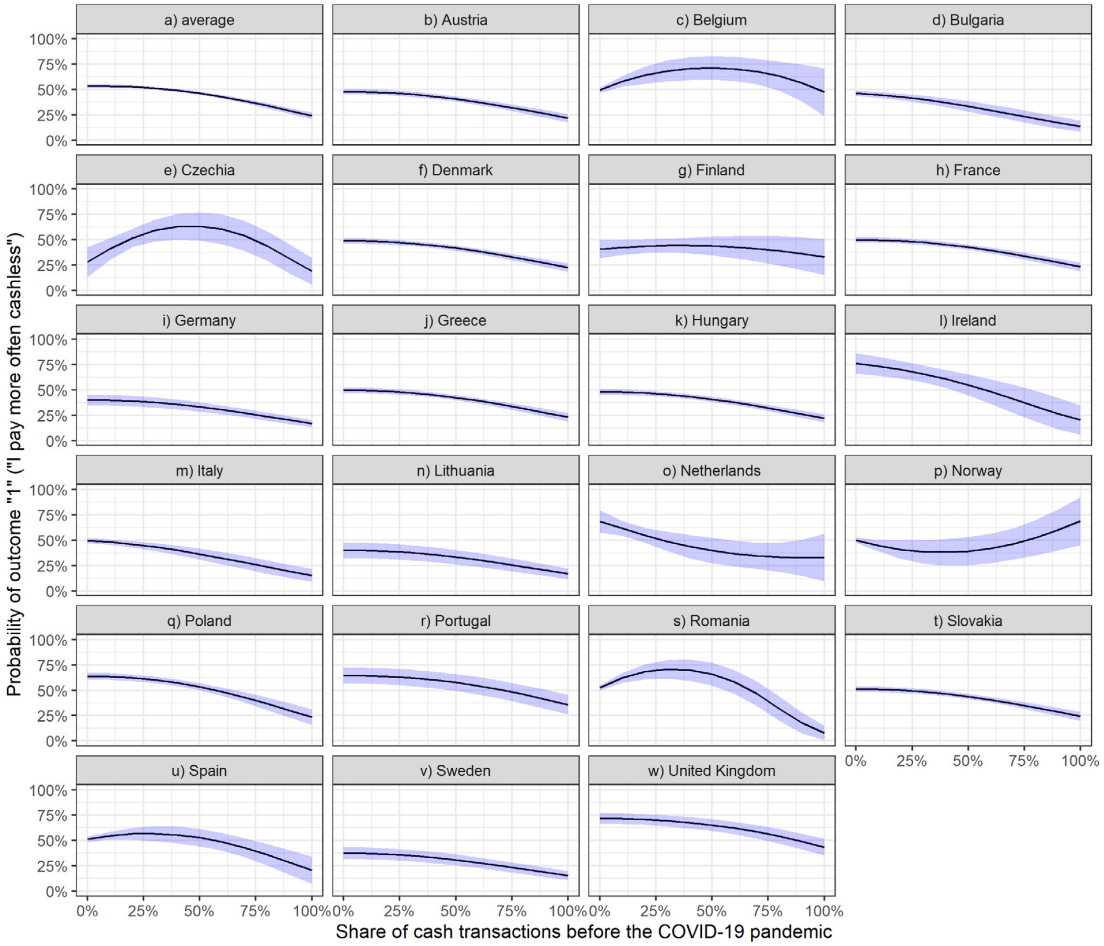

Fig. 2. Probability of adopting cashless instruments during the pandemic in different countries.
Note: Data present point estimate calculated with 95% confidence interval.

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Pandemia COVID-19 a popyt na pieniądz gotówkowy i zmiany w zachowaniach płatniczych w Polsce w 2020 r.

Streszczenie

Pandemia COVID-19 stała się katalizatorem raptownych zmian w zachowaniach społecznych oraz funkcjonowaniu współczesnych gospodarek. Tuż po jej ogłoszeniu, zarówno w Polsce, jak i Europie, gwałtowanie wzrósł popyt na gotówkę. Jednak dotychczasowe badania sugerują, że wzrost ten nie znalazł odzwierciedlenia w wartości płatności gotówkowych realizowanych przez konsumentów. W artykule badane są przyczyny wzrostu zapotrzebowania na gotówkę, jak również skala substytucji gotówki przez instrumenty bezgotówkowe. Do realizacji tego celu zastosowano szeroki zakres danych oraz metod analitycznych, które zgodnie z wiedzą autorów nie były dotychczas wykorzystywane dla rynku polskiego. Na podstawie uzyskanych wyników należy stwierdzić, że głównym powodem wzrostu

popytu na pieniądz gotówkowy była chęć jego tezauryzacji, przy jednoczesnym spadku wykorzystania gotówki do celów transakcyjnych w trakcie pandemii.

Słowa kluczowe: pandemia COVID-19, zachowania płatnicze, popyt na pieniądz, gotówka
Kody klasyfikacji JEL: E41, E42

Zastrzeżenie: Poglądy wyrażone w niniejszym opracowaniu są opiniami autorów i nie powinny być interpretowane jako stanowisko organów Narodowego Banku Polskiego.

1. Wprowadzenie

Światowa Organizacja Zdrowia w dniu 11 marca 2020 r. uznała chorobę COVID-19 za pandemię[1]. W jej efekcie istotnym zmianom uległo wiele aspektów codziennego życia. Rządy wielu krajów wprowadziły różnorodne restrykcje, mające na celu ograniczenie rozprzestrzeniania się choroby [Hale i in., 2021]. Praca oraz szkolnictwo zostały raptownie przestawione na funkcjonowanie w modelu zdalnym [Li, Lalani, 2020; Madgavkar, Lund, 2020]. Zmniejszeniu uległa mobilność ludności [Bounie, Camara, Galbraith, 2020]. Zmieniła się również konsumpcja gospodarstw domowych, w tym: jej wielkość [Christelis i in., 2020] oraz sposób jej dokonywania [Eger i in., 2021]. Pandemia COVID-19 przyspieszyła zmiany w zachowaniach płatniczych części społeczeństwa w kierunku rozwiązań bezgotówkowych [Kotkowski, Polasik, 2021], które są obserwowane już od wielu lat [Harasim, 2016].

Jednak, paradoksalnie, wraz ze wzrostem wykorzystania instrumentów bezgotówkowych do realizacji transakcji, istotnie wzrósł poziom gotówki w obiegu w Polsce. Stało się to pomimo faktu, iż szczególnie we wczesnej fazie pandemii w przestrzeni publicznej pojawiało się wiele informacji łączących rozprzestrzenianie się choroby z używaniem gotówki do realizacji płatności [Auer, Cornelli, Frost, 2020]. Co więcej, niektóre wyniki badań opublikowanych w czasie pandemii COVID-19 wskazują, że rozprzestrzenianie się chorób zakaźnych generalnie zmniejsza popyt na pieniądz gotówkowy [Cevik, 2020].

Celem artykułu jest zbadanie, jakie motywy kierowały wzrostem popytu na pieniądz gotówkowy oraz jak dokładnie w trakcie pandemii zmieniły się zachowania płatnicze w Polsce. W niniejszej pracy postawiono dwie tezy:

T1: Wzrost popytu na pieniądz gotówkowy[2] w trakcie pandemii COVID-19 nie był powodowany motywem transakcyjnym, a motywem tezauryzacyjnym.

T2: W trakcie pandemii COVID-19 nastąpiła zmiana zachowań płatniczych części konsumentów polegająca na ich przejściu w kierunku płatności bezgotówkowych.

[1] Szacuje się, że do końca września 2021 r. na świecie zakaziło się nią przynajmniej 232 mln osób, zaś w wyniku tych zakażeń zmarło przynajmniej 4,7 mln osób.

[2] W artykule przyjęto, że popyt na pieniądz gotówkowy równa się jego podaży, co wynika z potrzeby realizacji przez bank centralny istotnej roli stabilizatora systemu finansowego [Restoy, 2020].

Wnioski z niniejszego badania mogą okazać się przydatne dla pełniejszego zrozumienia funkcjonowania obrotu gotówkowego (szczególnie w kontekście zdarzeń ekstremalnych, takich jak pandemia chorób zakaźnych), a także planowania strategii rozwoju obrotu zarówno gotówkowego, jak i bezgotówkowego.

2. Popyt na pieniądz gotówkowy w Polsce w kontekście pandemii COVID-19

2.1. Motywy popytu na pieniądz gotówkowy

W literaturze znanych jest wiele teorii popytu na pieniądz, np. ilościowa teoria pieniądza, teoria preferencji płynności czy monetarystyczna teoria pieniądza (por. np. [Kaźmierczak, 2008]), które wskazują na różne motywy tego popytu, np. motywy transakcyjny, przezornościowy czy spekulacyjny [Keynes, 1936][3]. W ramach niniejszej analizy wykorzystano jednak podejście stosowane m.in. w publikacjach Europejskiego Banku Centralnego, gdzie wydziela się trzy komponenty popytu na pieniądz gotówkowy (w postaci banknotów):

- transakcyjny,
- tezauryzacyjny[4]
- zagraniczny (zarówno transakcyjny, jak tezauryzacyjny) (por. [Zamora-Pérez, 2021]).

W związku z lokalną, nie zaś globalną, pozycją polskiego złotego jako waluty, w dalszych rozważaniach pominięto kwestię popytu zagranicznego. Za takim podejściem przemawia zakres ograniczeń w mobilności, jaki miał miejsce w trakcie, głównie w pierwszych miesiącach, pandemii COVID-19 [https://ourworldindata.org/grapher/changes=-visitors-covid?country~POL]. Warto jednak zaznaczyć, że dla walut, takich jak dolar czy euro, szacuje się, że popyt zagraniczny dotyczy nawet 50% gotówki będącej w obiegu [Judson, 2017; Lalouette i in., 2021].

2.2. Popyt na pieniądz gotówkowy

Wartość pieniądza gotówkowego w obiegu (z kasami monetarnych instytucji finansowych) pomiędzy końcem grudnia 1996 r.[5] a końcem grudnia 2020 r., tj. na przestrzeni

[3] W wielkim skrócie popyt na pieniądz wynikający z motywu transakcyjnego wynika z potrzeby realizacji codziennych transakcji handlowych. Z kolei motyw przezornościowy wiąże się m.in. z potrzebą zabezpieczenia niespodziewanych transakcji (ale wynika również z postrzeganej niepewności co do możliwości swobodnego zaspokajania potrzeb w ujęciu ekonomicznym), zaś motyw spekulacyjny powodowany jest chęcią wykorzystania tych środków na rynku papierów wartościowych [Kaźmierczak, 2008].

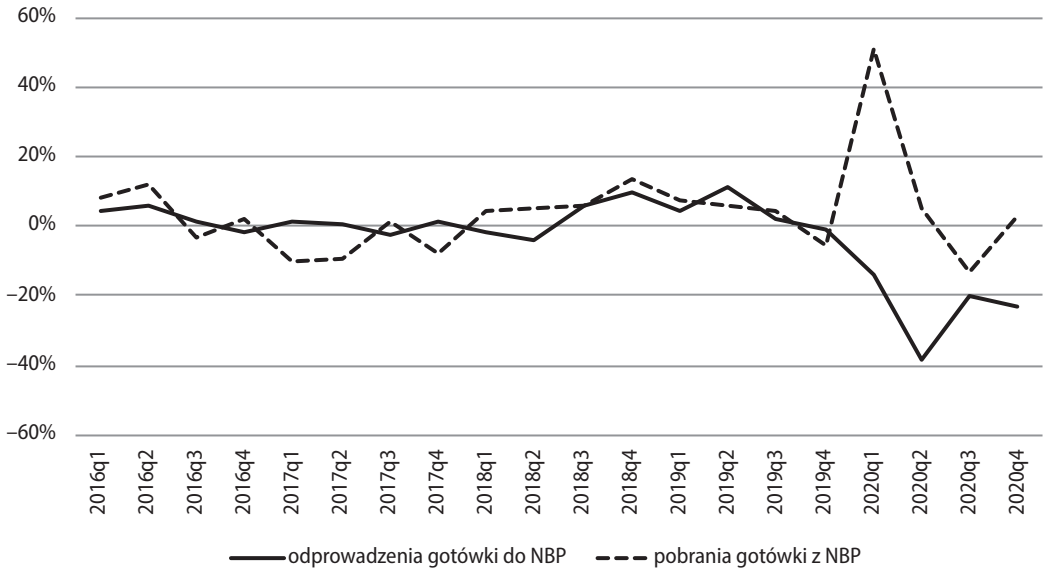
[4] Tezauryzacja rozumiana jako gromadzenie/przechowywanie wartości pieniężnej w celu zarządzania ryzykiem oraz płynnością.

[5] Zatem począwszy od ostatniego dnia, w którym zarówno „stare złote", jak i „nowe złote" były równocześnie prawnym środkiem płatniczym, zgodnie z art. 3 ust. 1 ustawy z dnia 7 lipca 1994 r. o denominacji złotego [Dz.U. 1994 nr 84, poz. 386].

14 lat, wzrosła nominalnie o 294 mld zł i osiągnęła poziom 321 mld zł. W tym czasie jego wartość w stosunku do PKB wzrosła z poziomu 5,5% do 13,2%. Wzrost relacji wartości pieniądza gotówkowego do PKB nie jest jednak zjawiskiem unikalnym. Podobne trendy obserwowane są w wielu rozwiniętych gospodarkach od połowy lat 80. / początku lat 90. XX w., kiedy to odwrócił się długotrwały trend spadku tej relacji obserwowany od końca II wojny światowej [Ashworth, Goodhart, 2020]. Jedynymi krajami, w których trend zmniejszania się udziału pieniądza gotówkowego w obiegu w relacji do PKB jest obserwowany nieustannie, są Szwecja i Norwegia [Armelius, Claussen, Reslow, 2020], tj. dwa kraje przodujące obecnie w zakresie rozwoju płatności bezgotówkowych.

W trakcie pandemii COVID-19 wzrost popytu na pieniądz gotówkowy w Polsce był jednak ponadprzeciętny. Według raportu Narodowego Banku Polskiego (dalej: NBP) pt. „Raport o obrocie gotówkowym w Polsce w 2019 r." gwałtowny spadek odprowadzeń gotówki do NBP oraz wzrost pobrań gotówki z NBP rozpoczął się już w dniu 12 marca 2020 r. [Fijałek i in., 2020]. Na rysunku 1 przedstawiono tempo zmiany wartości odprowadzeń i pobrań gotówki do/z NBP.

Rysunek 1. Tempo zmian wartości odprowadzeń i pobrań gotówki do/z NBP (r./r.)

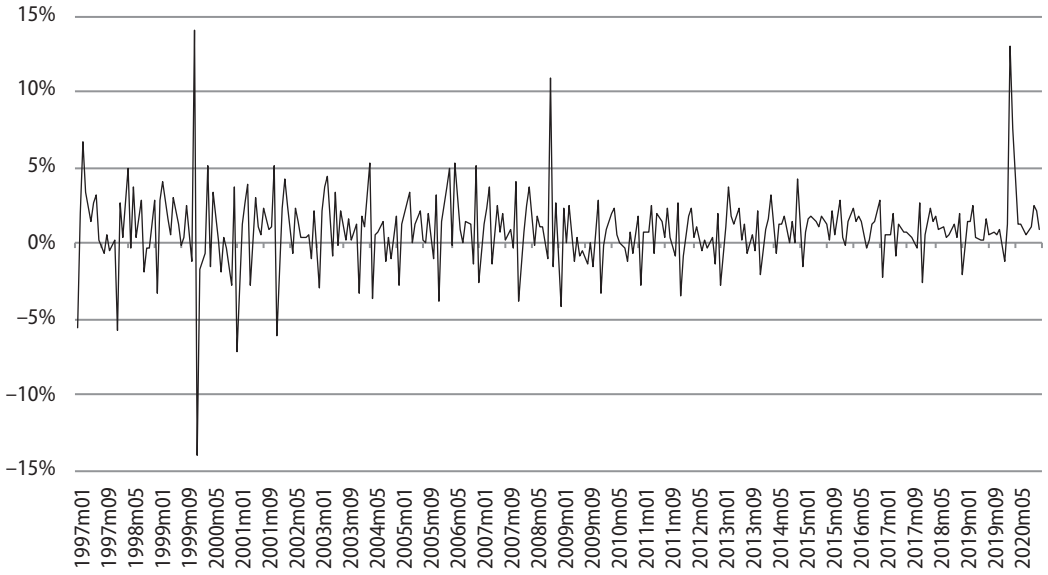


Źródło: obliczenia własne na podstawie danych NBP [https://www.nbp.pl/statystyka/pieniezna_i_bankowa/struktura-obiegu.html].

Przyjmując luty 2020 r. za datę bazową do dalszych analiz, należy wskazać, że wartość gotówki w obiegu tylko w marcu 2020 r. wzrosła o 13%. W analizie popytu na pieniądz gotówkowy od grudnia 1996 r. widać, że marcowy wzrost wartości gotówki w obiegu był drugim najwyższym wzrostem poziomu tego wskaźnika z miesiąca na miesiąc. Ustępował jedynie sytuacji z grudnia 1999 r., kiedy w stosunku do listopada zanotowano wzrost o 14% (przyczyną tak dużego popytu był wtedy najprawdopodobniej strach przed tzw. pluskwą

milenijną[6], obserwowany również w innych krajach [Assenmacher, Seitz, Tenhofen, 2019]). Zaobserwowany wzrost był jednocześnie wyższy niż na przykład wzrost spowodowany upadkiem banku Lehman Brothers we wrześniu 2008 r. (w październiku 2008 r. poziom gotówki w obiegu w Polsce wzrósł o 11% w stosunku do września 2008 r.). Tempo zmian wartości gotówki w obiegu z miesiąca na miesiąc zaprezentowano na rysunku 2.

Rysunek 2. Tempo zmian wartości pieniądza gotówkowego (z kasami monetarnych instytucji finansowych) w Polsce (m./m.)



Źródło: obliczenia własne na podstawie danych NBP [https://www.nbp.pl/statystyka/pieniezna_i_bankowa/m3.html].

Na koniec 2020 r. w stosunku do lutego 2020 r. poziom gotówki w obiegu był w Polsce wyższy o 35%. Był to najwyższy zaobserwowany wzrost poziomu gotówki w obiegu w porównaniu na przykład z innymi państwami Unii Europejskiej, Szwajcarią, Wielką Brytanią czy Stanami Zjednoczonymi (rysunek 3). Przeciętne tempo wzrostu w okresie luty–grudzień 2020 r. dla tych krajów wyniosło 12%.

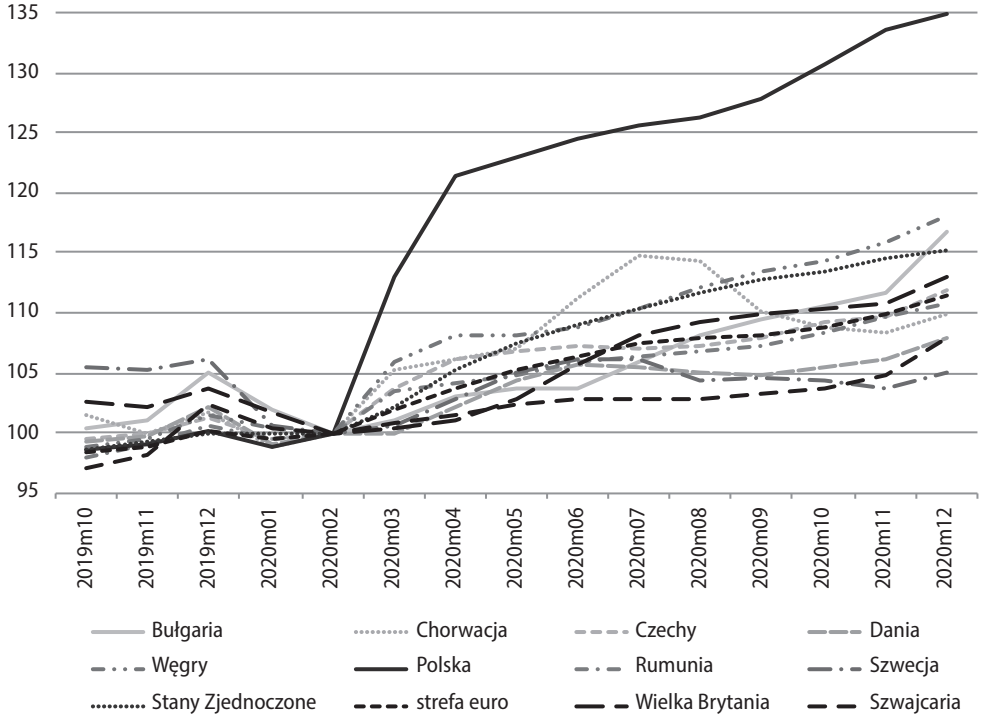
W celu rozróżnienia, czy obserwowany ogólny wzrost popytu na gotówkę wynikał z potrzeb transakcyjnych czy też tezauryzacyjnych, należy, w opinii autorów, zwrócić uwagę na dwa zjawiska:

- pogłębienie spadku tempa rotacji monet i banknotów, obliczanego przez NBP i pokazującego, co (moneta lub banknot) ile razy w ciągu ostatnich czterech kwartałów powracało do NBP, który znajduje się w długotrwałym trendzie spadkowym (rysunek 4);

[6] Nazywaną również „problemem roku 2000", tj. strachem, że wraz z nastaniem roku 2000 część oprogramowania komputerowego przestanie funkcjonować poprawnie z uwagi na problem ze sposobem zapisu daty. Miało to z kolei spowodować kłopoty z dalszym funkcjonowaniem gospodarki, m.in. w związku z potencjalnym zamknięciem elektrowni, stacji uzdatniania wody itd.

- wzrost popytu na gotówkę o wysokich nominałach, przy relatywnie małym wzroście popytu na monety i banknoty o niskich nominałach (rysunek 5).

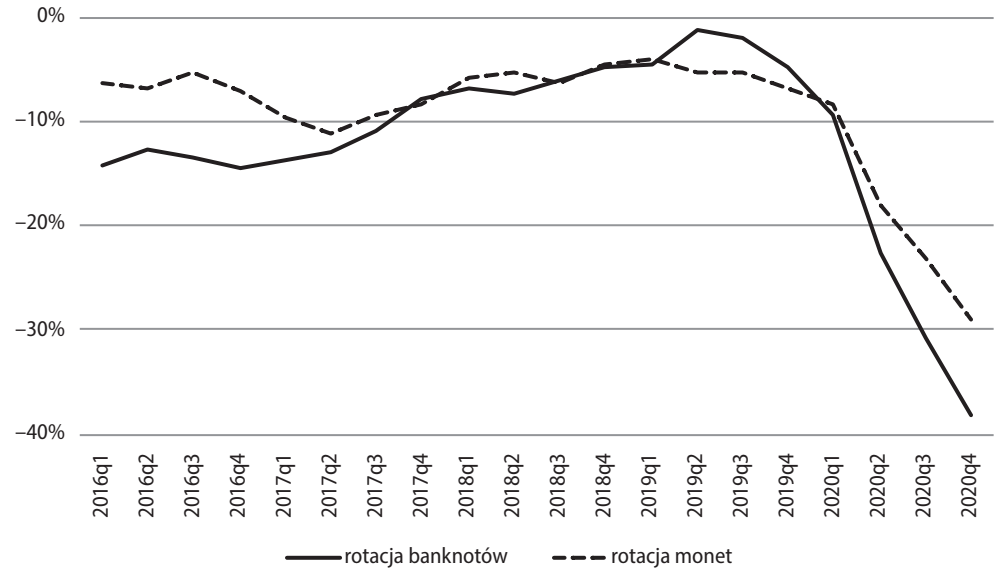
Rysunek 3. Wartości gotówki w obiegu (z kasami monetarnych instytucji finansowych) w wybranych obszarach monetarnych (indeks, luty 2020 = 100)



Źródło: opracowanie własne na podstawie danych Międzynarodowego Funduszu Walutowego, Banku Anglii, Szwajcarskiego Banku Narodowego, Europejskiego Banku Centralnego i Banku Rezerw Federalnych w St. Louis.

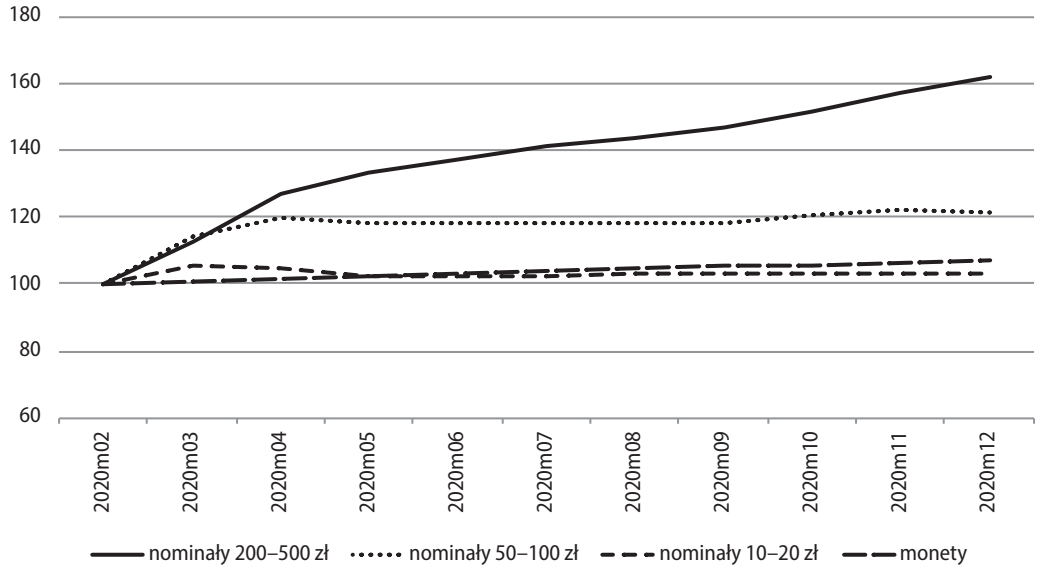
Spadek tempa rotacji monet i banknotów może wskazywać na ich relatywnie rzadsze wykorzystywanie. Z kolei analiza popytu na konkretne nominały wykazała, że największy popyt realizował się w odniesieniu do nominałów o wysokiej wartości (200–500 zł) i trwał on nieustannie od początku pandemii do końca 2020 r. Popyt na nominały średnie (50–100 zł) był zwiększony tylko w okresie dwóch pierwszych miesięcy pandemii, zaś popyt na nominały niskie (10–20 zł) oraz monety uległ tylko nieznacznemu wzrostowi. W ślad za A. Baileyem [2009] oraz M. Bechem i in. [2018] należy uznać, że popyt na banknoty o nominałach wysokiej wartości reprezentuje motyw tezauryzacyjny, a w konsekwencji, że popyt na pieniądz gotówkowy realizowany w efekcie pandemii COVID-19 w 2020 r. nie służył celom transakcyjnym, co zostanie dodatkowo udowodnione w analizie przeprowadzonej w następnym punkcie opracowania.

Rysunek 4. Zmiany rotacji banknotów i monet (r./r.)



Źródło: obliczenia własne na podstawie danych NBP [https://www.nbp.pl/statystyka/pieniezna_i_bankowa/struktura-obiegu.html].

Rysunek 5. Wartość gotówki w obiegu (z kasami monetarnych instytucji finansowych) w podziale na nominały (indeks, luty 2020 = 100)



Źródło: obliczenia własne na podstawie danych NBP [https://www.nbp.pl/statystyka/pieniezna_i_bankowa/struktura-obiegu.html].

3. Zmiany w zachowaniach płatniczych w trakcie pandemii

3.1. Badania nad zachowaniami płatniczymi

Badania nad determinantami wykorzystania poszczególnych instrumentów płatniczych są realizowane, począwszy od przełomowej pracy W.C. Boeschotena i M.M.G. Fase'a [1989], od końca lat 80. XX w. Przeprowadzane obecnie badania wskazują na całe spektrum aspektów, które mają wpływ na to, jaki instrument płatniczy zostanie wykorzystany w trakcie realizacji transakcji płatniczej [Świecka, Terefenko, Paprotny, 2021]. Znaczenie mają takie czynniki, jak: charakterystyka socjo-demograficzna konsumenta [Marzec, Polasik, Fiszeder, 2013; van der Cruijsen i van der Horst, 2019], wiedza finansowa konsumenta [Harasim, Klimontowicz, 2016; Świecka i in., 2021], postrzegane przez niego cechy danych instrumentów płatniczych [Harasim, Klimontowicz, 2017; Koulayev i in., 2016], charakterystyka transakcji [Arango-Arango i in., 2018; Bagnall i in., 2016], promocje oferowane przez wydawców kart [Polasik i in., 2012], czy po prostu koszty związane z posiadaniem lub realizacją transakcji daną metodą płatności [Arango-Arango i in., 2018].

Skala wykorzystania poszczególnych typów instrumentów jest szacowana i badana przede wszystkim przez banki centralne. Do banków, które cyklicznie realizują badania na ten temat, można zaliczyć m.in. banki centralne: strefy euro [ECB, 2020], Stanów Zjednoczonych [Foster, Greene, Stavins, 2020; Greene, Stavins, 2020], Australii [Delaney, McClure, Finlay, 2020], Kanady [Henry, Huynh, Welte, 2018], Danii [Heisel, 2020] czy Polski. Badania dotyczące zachowań płatniczych w Polsce były zrealizowane przez NBP do tej pory trzykrotnie: na przełomie lat 2011 i 2012 [Koźliński, 2013], w 2016 r. [Manikowski, 2017] oraz w 2020 r. [Kotkowski, Dulinicz, Maciejewski, 2021]. Potrzeba wykonywania tego typu badań wynika przede wszystkim z faktu, iż transakcje gotówkowe, w przeciwieństwie do transakcji bezgotówkowych, cechuje anonimowość [Borgonovo i in., 2021]. W związku z tym, na chwilę obecną, nie ma możliwości ich rejestrowania na masową skalę. Do metod szacowania wykorzystania gotówki do realizacji transakcji należą m.in. następujące metody [Schmiedel, Kostova, Ruttenberg, 2012]:

- ankiety skierowane do konsumentów,
- metoda wypłat gotówkowych,
- ankiety skierowane do handlowców,
- szacunki na podstawie statystyk z kas fiskalnych,
- metoda wpłat gotówki z utargów handlowców,
- metoda konsumpcji rezydualnej,
- metoda cyrkulacji rezydualnej[7].

[7] Pogłębione opisy wskazanych metod zawarte są m.in. w opracowaniach przygotowanych pod egidą Europejskiego Banku Centralnego [Schmiedel, Kostova, Ruttenberg, 2012] czy w raporcie z badania dotyczącego kosztów instrumentów płatniczych przeprowadzonego przez NBP w latach 2015–2018 [Przenajkowska i in., 2019].

Badania przeprowadzane w ostatnich latach przez banki centralne są realizowane przede wszystkim przy wykorzystaniu metody ankiety skierowanej do konsumentów, w szczególności za pomocą tzw. dzienniczka płatności. Metoda polega na tym, że ankietowani są proszeni o rejestrację wszystkich transakcji płatniczych zrealizowanych w trakcie badania. Chociaż badania metodą dzienniczka płatności wykazują pewne niedoskonałości (np. respondenci zapominają rejestrować informacje o transakcjach na małe kwoty lub specjalnie ukrywają niektóre transakcje [Jonker i Kosse, 2009; Schmidt, 2014]), to mimo wszystko uznaje się, że badania tego typu przedstawiają realistyczny obraz wykorzystania poszczególnych instrumentów płatniczych [Gresvik, Haare, 2008; Schmiedel, Kostova, Ruttenberg, 2012].

O ile jednak w czasach normalnej aktywności gospodarczej badania dzienniczkowe dość dobrze oddają zachowania płatnicze mieszkańców danego kraju, o tyle to, w jaki sposób są realizowane punktowo w czasie, sprawia, że trudno na ich podstawie wnioskować o zmianach dynamicznych (szczególnie gdy badania nie odbywają się co roku). Na przykład zestawienie badań przeprowadzonych przez NBP w ostatnich latach wskazuje na malejącą skalę wykorzystania gotówki w przypadku transakcji detalicznych (tabela 1). Dopiero pogłębiona ankieta przeprowadzona wraz z badaniem dzienniczkowym w 2020 r. wykazała, że część zmian, jaka zaszła pomiędzy latami 2016 a 2020, faktycznie wynikła z wystąpienia pandemii COVID-19[8] [Kotkowski i in., 2021].

Tabela 1. Szacowany udział transakcji gotówkowych w ogólnej liczbie i wartości transakcji w badaniach NBP (w %)

Udział w ogólnej	Lata		
	2011/2012	2016	2020
liczbie transakcji	81,8	53,9	46,4
wartości transakcji	63,7	40,7	29,3

Źródło: opracowanie własne na podstawie badań NBP [Koźliński, 2013; Manikowski, 2017; Kotkowski i in., 2021].

Dotychczas przeprowadzone badania wskazują, że skala deklarowanych zmian zachowań płatniczych w trakcie pandemii COVID-19 była istotna i ukierunkowana raczej na rozwiązania bezgotówkowe (por. np. [Kotkowski, Polasik, 2021]). Wśród czynników determinujących taką zmianę wskazuje się m.in.:

- wpływ środków podjętych przez rządy państw w celu opanowania pandemii [Jonker i in., 2020],
- strach przed zarażeniem wirusem SARS-CoV-2 w wyniku kontaktu z gotówką [Huterska, Piotrowska, Szalacha-Jarmużek, 2021; Wisniewski i in., 2021],
- zmianę w zachowaniach konsumenckich przez:
  - substytucję handlu w fizycznych punktach handlowo-usługowych (PHU) handlem internetowym [Bounie, Camara, Galbraith, 2020];

[8] 34,6% badanych zadeklarowało, że w związku z pandemią COVID-19 zmieniło swoje zachowania płatnicze. Spośród tych osób 81,7% zaczęło częściej płacić bezgotówkowo, zaś 18,3% – gotówkowo.

– zmniejszenie częstotliwości dokonywania zakupów przy jednoczesnym wzroście wartości dokonywanych zakupów, co z kolei częściej wiąże się z dokonywaniem transakcji bezgotówkowych [Kotkowski, Dulinicz, Maciejewski, 2021].

3.2. Szacunki wykorzystania gotówki w trakcie pandemii COVID-19

W celu bardziej dokładnego zbadania dynamiki zmian zachowań płatniczych oszacowano udział transakcji gotówkowych (w ogólnej wartości transakcji) przy użyciu trzech metod wykorzystanych w ostatnim okresie przez T. Khiaonaronga i D. Humphreya [2019], które łączą w sobie podejście szacowania na podstawie wypłat gotówkowych oraz konsumpcji rezydualnej i umożliwiają szacowanie na agregatach. Są to metody:

m_1 – klasycznego szacowania konsumpcji rezydualnej,

m_2 – udziału wypłat gotówkowych w wydatkach gospodarstw domowych,

m_3 – udziału wypłat gotówkowych w ogólnej wartości wypłat gotówkowych i transakcji płatniczych realizowanych bliskimi substytutami gotówki.

Do oszacowania udziału transakcji gotówkowych wykorzystano szereg zmiennych, zaprezentowanych w tabeli 2. Wszystkie wskazane dane są zbierane w Polsce z częstotliwością kwartalną, co z kolei pozwoliło na bliższe przyjrzenie się dynamice zmian.

Do szacowania wyników poszczególnych metod wykorzystano wzory:

$$m_1 = \frac{(spożycie\_POS - transakcje\_POS)}{spożycie\_POS} \tag{1}$$

$$m_2 = \frac{(wypłaty\_ATM + wypłaty\_inne)}{spożycie\_POS} \tag{2}$$

$$m_3 = \frac{(wypłaty\_ATM + wypłaty\_inne)}{(wypłaty\_ATM + wypłaty\_inne + transakcje\_POS)} \tag{3}$$

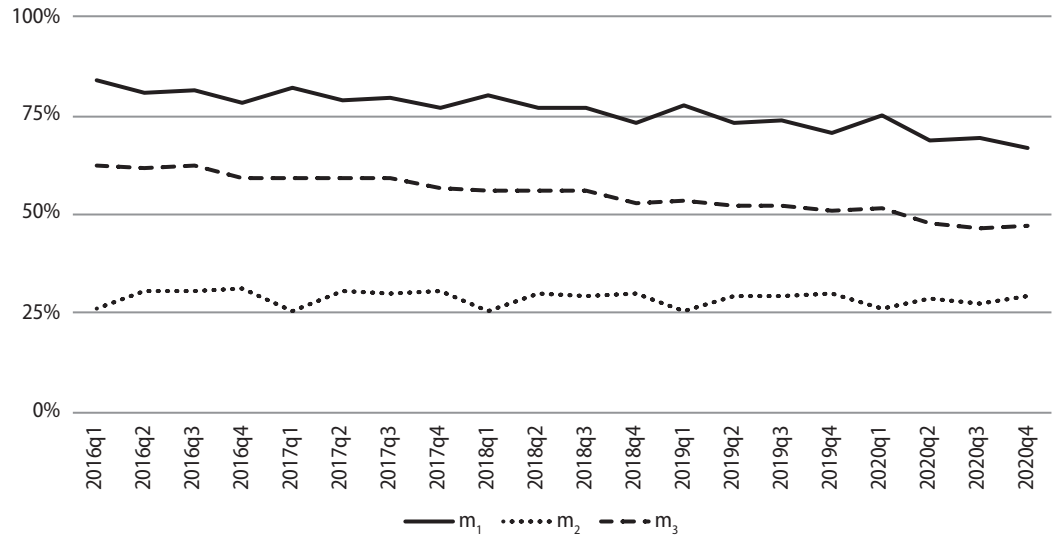
Tabela 2. Definicje zmiennych wykorzystanych w badaniu

Zmienna	Definicja	Źródło
spożycie	Spożycie w sektorze gospodarstw domowych	GUS
karty_POS	Wartość transakcji bezgotówkowych zrealizowanych kartami płatniczymi wydanymi w Polsce w terminalach płatniczych w kraju	NBP
karty_INT	Wartość transakcji bezgotówkowych zrealizowanych kartami płatniczymi wydanymi w Polsce w sieci Internet w kraju	
karty_ATM	Wartość wypłat gotówkowych zrealizowanych kartami płatniczymi wydanymi w Polsce w bankomatach	
karty_CB	Wartość wypłat gotówkowych zrealizowanych kartami płatniczymi wydanymi w Polsce z wykorzystaniem usługi *cash back*	

Zmienna	Definicja	Źródło
karty_CA	Wartość wypłat gotówkowych zrealizowanych kartami płatniczymi wydanymi w Polsce z wykorzystaniem usługi *cash advance*	NBP
pay-by-link	Wartość wypłat gotówkowych zrealizowanych kartami płatniczymi wydanymi w Polsce z wykorzystaniem usługi *cash advance*	
BLIK_POS	Wartość transakcji BLIK zrealizowanych w terminalach płatniczych w kraju	
BLIK_INT	Wartość transakcji BLIK zrealizowanych w sieci Internet w kraju	
BLIK_ATM	Wartość wypłat gotówkowych zrealizowanych przy wykorzystaniu BLIK w bankomatach	
BLIK_wypłaty_inne	Wartość wypłat gotówkowych zrealizowanych przy wykorzystaniu BLIK w innych miejscach	
spożycie_POS	Spożycie w sektorze gospodarstw domowych (*spożycie*) po odjęciu transakcji bezgotówkowych w handlu internetowym (*karty_INT*, *pay-by-link*, *BLIK_INT*)	obliczenia własne
transakcje_POS	Suma transakcji bezgotówkowych kartami płatniczymi (*karty_POS*) i BLIK (*BLIK_POS*) w terminalach płatniczych	
wypłaty_ATM	Suma transakcji gotówkowych kartami płatniczymi (*karty_ATM*) i BLIK (*BLIK_ATM*) w bankomatach	
wypłaty_inne	Suma transakcji gotówkowych kartami płatniczymi (*karty_CB* i *karty_CA*) i BLIK (*BLIK_wypłaty_inne*) w miejscach innych niż bankomaty	

Źródło: opracowanie własne.

Rysunek 6. Szacunkowy udział transakcji gotówkowych w ogólnej wartości transakcji



Źródło: opracowanie własne na podstawie badań empirycznych.

Wyniki szacunków z wykorzystaniem trzech wyżej wskazanych metod zaprezentowano na rysunku 6[9]. Zgodnie z założeniami teoretycznymi m_1 przedstawia maksymalny możliwy

[9] Dane wykorzystane do szacowania modeli są dostępne u autorów na żądanie.

udział transakcji gotówkowych, zaś m_2 poziom minimalny. Udział transakcji gotówkowych szacowany przy wykorzystaniu metody dzienniczka płatności (por. tabela 1) znajdował się pomiędzy granicami wyznaczonymi przez szacunki dla m_2 i m_3.

Na podstawie uzyskanych wyników należy zauważyć, że udział transakcji gotówkowych w ogólnej wartości realizowanych transakcji detalicznych znajduje się w długoterminowym trendzie spadkowym. Należy przy tym zaznaczyć, że tempo zmian istotnie zależało od wykorzystanej metody. Największe tempo spadku wykorzystania gotówki jest wyznaczane przez m_3, dla której w okresie 2017–2019 wynosiło ono średnio (w ujęciu r./r.) 5,2%, dla m_1 obserwowane tempo spadku wynosi 3,1%, zaś dla m_2 1,3%. Podsumowanie tempa zmian udziału zostało przedstawione w tabeli 3.

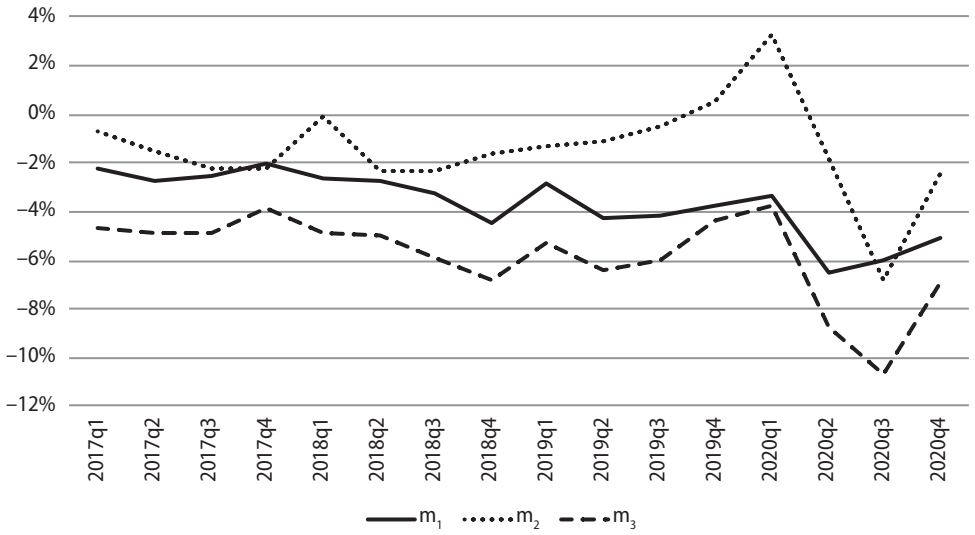
Tabela 3. Porównanie tempa zmian udziału transakcji gotówkowych w ogólnej wartości transakcji detalicznych w poszczególnych latach (r./r., w %)

Metoda	2017–2019					2020			
	q1	q2	q3	q4	średnio	q1	q2	q3	q4
m_1	–2,6	–3,2	–3,3	–3,4	–3,1	–3,4	–6,5	–6,0	–5,1
m_2	–0,7	–1,7	–1,7	–1,1	–1,3	3,3	–1,9	–6,8	–2,4
m_3	–4,9	–5,4	–5,6	–5,0	–5,2	–3,7	–8,8	–10,7	–6,9

Źródło: opracowanie własne na podstawie badań empirycznych.

Porównanie tempa zmian udziału transakcji gotówkowych w ogólnej wartości transakcji detalicznych pomiędzy okresem 2017–2019 a 2020 r. wskazuje, że pandemia COVID-19 pogłębiła obserwowany trend, co przedstawiono na rysunku 7.

Rysunek 7. Tempo zmian szacunkowego udziału transakcji gotówkowych w ogólnej wartości transakcji detalicznych (r./r.)



Źródło: opracowanie własne na podstawie badań empirycznych.

W zależności od wykorzystywanej metody tempo spadku wzrosło od 164% (dla m_3) do 241% (dla m_2). Największe spadki wykorzystania gotówki były obserwowane w III kw. 2020 r., kiedy tempo zmian pogłębiło się średnio o 258%. Porównanie tempa zmian udziału transakcji gotówkowych przedstawiono w tabeli 4.

Tabela 4. Porównanie tempa zmian udziału transakcji gotówkowych w ogólnej wartości transakcji detalicznych (w %)

Metoda	Porównanie średniej zmiany dla lat 2017–2019 i 2020 r.				
	q1	q2	q3	q4	Średnia dla metody (dla q2, q3 i q4)
m_1	131	201	179	149	177
m_2	–490	110	404	209	241
m_3	76	163	191	138	164
średnia w kwartale	–95	158	258	165	194

Obszar zaznaczony kolorem szarym wskazuje na okres trwania pandemii COVID-19.

Źródło: opracowanie własne na podstawie badań empirycznych.

3.3. Ograniczenia metodyczne

Podczas przygotowania szacunków zastosowano kilka założeń upraszających, które należy mieć na uwadze, szczególnie podczas prób replikowania niniejszego badania.

- Z danych o spożyciu w sektorze gospodarstw domowych nie zostały odjęte pozycje dotyczące „użytkowania mieszkania lub domu i nośników energii" oraz „łączności", które w Polsce są opłacane zazwyczaj za pomocą poleceń przelewu. Dostępny w trakcie pisania niniejszego artykułu „Mały rocznik statystyczny Polski za rok 2021" [GUS, 2021] zawierał informacje na temat szczegółów spożycia w tym sektorze do 2019 r. włącznie (ww. pozycje stanowiły ok. 22% wydatków), jednak z uwagi na pandemię COVID-19 postanowiono nie ekstrapolować tych danych na 2020 r. z uwagi na potencjalną zmianę tego udziału w ogólnej kompozycji wydatków.
- Szacując spożycie w sektorze gospodarstw domowych bez transakcji bezgotówkowych w handlu internetowym, pominięto transakcje dokonywane przy użyciu usług lub rozwiązań płatniczych, dla których pozyskanie danych jest utrudnione lub występuje zupełny brak danych (np. gotówka czy inne, mniej popularne metody płatności bezgotówkowych).
- W momencie pisania niniejszego artykułu w Polsce nie były zbierane dane dotyczące liczby i wartości wypłat gotówkowych w oddziałach banków, co stanowi jeden z elementów szacunków wykonywanych m.in. przez T. Khiaonaronga i D. Humphreya [2019]. Z jednej strony ich brak zaniża szacunki dla m_2 i m_3, z drugiej strony można argumentować, iż wypłaty w oddziałach banków, których średnia wartość jest wyraźnie większa niż w przypadku wypłat z bankomatów i przy wykorzystaniu usługi *cash back* (por. np. [Kotkow-

ski, Dulinicz, Maciejewski, 2021]), zdecydowanie rzadziej jest realizowana na potrzeby bieżące (transakcyjne), a częściej realizuje inne motywy popytu na pieniądz.

- Z udostępnianych przez NBP danych dotyczących transakcji kartami płatniczymi nie można wydzielić transakcji dokonanych kartami biznesowymi a realizowanych bezgotówkowo (średni udział transakcji tego typu kartami w ogólnej wartości transakcji, zarówno gotówkowych, jak i bezgotówkowych, w okresie od I kw. 2016 r. do IV kw. 2020 r. wyniósł 15,3%).
- Transakcje BLIK w bankomatach od III kw. 2017 r. zawierają dane dotyczące wypłat, ale także wpłat, których rozdzielenie nie jest możliwe. Z uwagi na to, że transakcje gotówkowe w bankomatach przy wykorzystaniu BLIK stanowiły łącznie 2,1% ogólnej wartości wypłat gotówkowych w okresie od I kw. 2016 r. do IV kw. 2020 r., zaakceptowano to przeszacowanie.

4. Podsumowanie

W artykule zwrócono uwagę na interesujący fenomen gwałtowanego wzrostu popytu na pieniądz ogółem, ze szczególnym uwzględnieniem pieniądza gotówkowego, w kontekście pandemii COVID-19, która w 2020 r. rozprzestrzeniła się na świecie, w tym w Polsce, oraz na to, jak w okresie pandemii zmieniał się sposób realizacji płatności.

Uzyskane wyniki wskazują, że wykorzystanie gotówki do celów transakcyjnych ulega w ostatnich latach zmniejszeniu. Obserwacja ta jest zgodna z trendami międzynarodowymi, jak również krajowymi. Należy jednak podkreślić, że w efekcie pandemii COVID-19 użycie gotówki do celów transakcyjnych spadło nawet dwukrotnie szybciej niż w okresach poprzedzających pandemię. Ustalono to w niniejszym artykule przy wykorzystaniu metod analiz niestosowanych wcześniej dla Polski.

Paradoksalnie, pomimo spadku wykorzystania gotówki do celów transakcyjnych, wzrosło ogólne zapotrzebowanie na gotówkę. Przeprowadzone analizy sugerują, że głównym powodem wzrostu popytu na pieniądz gotówkowy była chęć jego tezauryzacji. Obserwacja ta jest zgodna z wnioskami z badań J. Pietruchy i G. Maciejewskiego [2020]. Wskazali oni bowiem, że użytkownicy bezgotówkowych instrumentów płatniczych zwracają uwagę na potencjalne ryzyko związane z realizacją transakcji bezgotówkowych (np. niedziałający terminal płatniczy POS czy inne problemy techniczne) i zabezpieczają się przed nimi poprzez utrzymywanie rezerw gotówkowych. Można także argumentować, że obserwowany w trakcie pandemii popyt był generowany przez konsumentów w celu zabezpieczenia się przed potencjalnymi awariami sieci płatniczych lub zakłóceniami w swobodnym dostępie do gotówki zgromadzonej na rachunkach bankowych.

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The COVID-19 pandemic and changes in the demand for cash and payment behaviour in Poland in 2020

Summary

COVID-19 pandemic has become the catalyst of rapid changes taking place in social behaviour and in *modus operandi* of contemporary economies. Immediately after the outbreak of the pandemic was declared, in Poland and in Europe demand for cash soared. However, the studies conducted so far suggest that the increase has not been reflected in the value of cash payments made by consumers. The paper explores reasons why demand for cash grew, as well as the scale of substitution of cash by cashless instruments. To achieve this goal, the authors deployed a broad spectrum of data and analytical methods which, to the best of their knowledge, had never been used before to examine the Polish market. The obtained results have led to the conclusion that the main reason why demand for cash increased was the wish to use it to store value while, at the same time, the usage of cash in transactions during the pandemic exhibited a downward trend.

Keywords: COVID-19 pandemic; payment behaviour; demand for cash; cash

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National culture and the demand for physical money during the first year of the COVID-19 pandemic

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ABSTRACT

There was a significant increase in the demand for physical money during the COVID-19 pandemic. This stood in stark contrast to the decline in demand witnessed during previous pandemics. However, the change was not uniform and varied significantly between countries. By employing the "national culture" framework to identify the drivers of this variation, this study found that uncertainty avoidance, as well as social norms regarding gratification, played a major role. This suggests that some central banks should hold larger cash reserves to mitigate the risk of uncertainty and that the national culture framework may prove useful in researching the international differences in past, present, and future money demand.

1. Introduction

Physical money (also referred to as "cash" or "currency" in this paper) is being used less and less for everyday transactions. For example, the proportion of retail and person-to-person payments made in cash fell from around 79% to 73% (ECB, 2020) in the euro area, 31% to 26% in the US (Greene & Stavins, 2021), and 40% to 23% in the UK (Caswell et al., 2020) in 2016-2019. However, cash is not disappearing. On the contrary, the demand for cash has been steadily rising in absolute terms over the past few decades (Ashworth & Goodhart, 2020; Pietrucha, 2021), with non-transactional demand reported to be the major driver of this increase (Zamora-Pérez, 2021).

The COVID-19 pandemic accelerated both phenomena. Recent studies show that, during the pandemic, cashless instruments usage intensified (Greene et al., 2021; Jonker et al., 2022; Kotkowski & Polasik, 2021) while the demand for cash increased (Ashworth & Goodhart, 2021; Rösl & Seitz, 2021). Moreover, this occurred despite cash being used less frequently in retail transactions due to the fear of contracting COVID-19 through handling money (ECB, 2020; Huterska et al., 2021; Wisniewski et al., 2021) and despite the findings of Cevik (2020), who demonstrated that the demand for cash had decreased during previous epidemics (e.g. during the Ebola and SARS epidemics).

However, this observed increase in the demand for physical money was not uniform worldwide. IMF International Financial Statistics database (IMF IFS) data for 128 countries shows that the value of currency in circulation increased on average by 18.7% in 2020, but that this change varied from a 7.5% decrease to a 120.5% increase. In this paper I employ "national culture" dimensions to explain this variation. The usefulness of "national culture" is supported by the growing body of literature on the subject, which covers such broad financial topics as, for example, (i) firm behavior (Boubakri et al., 2021; Chen et al., 2015; Moro et al., 2021), (ii) financial development (Cao et al., 2020; Khan et al., 2022; Kwok & Tadesse, 2006; Makrychoriti & Pasiouras, 2021), (iii) financial literacy and

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inclusion (Ahunov & Van Hove, 2020b; Anyangwe et al., 2022), or (iv) stock behavior (Ashraf, 2021).

Within this framework, "national culture" is defined as the "collective programming of the mind which distinguishes the members of one human group from another (...) the interactive aggregate of common characteristics that influence a human group's response to its environment" (Hofstede, 1980, p. 25). Hofstede and his collaborators distinguished 6 "national culture" measurements (Hofstede, 2011; Hofstede et al., 2010):

(i) the power distance index (PDI), which measures the degree of acceptance of perceived unequal power distribution;
(ii) individualism vs. collectivism (IDV), which measures the degree of preference for individual over collective identity;
(iii) masculinity vs. femininity (MAS), which measures the degree of preference for assertiveness and competitiveness over passivity and cooperation;
(iv) the uncertainty avoidance index (UAI), which measures the degree of preference for fixed laws, procedures etc. over uncertainty;
(v) long-term orientation vs. short-term normative orientation (LTO), which measures the tendency for long-term saving, planning etc. in preference to short-term consumption;
(vi) indulgence vs. restraint (IVR), which measures the perceived allowance or tolerance of gratification vs. its restriction by social norms.

As it is already established that precautionary demand is positively related to higher uncertainty (Leland, 1968) a central assumption of this paper is that, in the face of extraordinary events, and, therefore, an increase in uncertainty, the demand for cash will be higher in more uncertainty-avoidant societies (with higher UAI). It can be argued that, as cash is both an asset and a secure and widely accepted means of payment that is not susceptible to technological failures (Eschelbach & Schneider, 2020; Pietrucha & Maciejewski, 2020), holding it (or even hoarding) would ease uncertainty about the future.

The other "national culture" variables are assumed by me to have a lesser impact. Nonetheless, I speculate that the demand for cash should be higher in more indulgent nations (with higher IVR) as they would probably spend more for consumption. This effect could be especially visible in countries where cash usage is high. I also assumed that cash demand would be higher in more individualistic and competitive cultures (with higher IDV and MAS), as it seems less likely that increased cash demand would be confined by considerations about other people in society. By contrast, demand for cash is assumed by me to be lower in nations with long-orientation (with high LTO) and with less challenged hierarchy (with higher PDI). In the former case, this is because societies with a long-term focus are less likely to react impulsively to events, especially if these risks exacerbating the situation (e.g., bank runs), and in the latter case, because more compliant societies might better response to the authorities tries to ease up the pressure (by sending calming messages or imposing restrictions).

The paper is structured as follows: Section 2 introduces the data and the methodology; Section 3 details the empirical results; and Section 4 presents the findings and conclusions.

2. Data and method

The analysis employed in this study was based on a balanced panel dataset for 58 countries for the period between February 2020 and February 2021. However, due to the fixed nature of "national culture" variables, the analysis was performed employing a series of 12 cross-sectional OLS regressions. Each regression focused on a single month, beginning with March 2020—the month of the official declaration of the pandemic—and ending with February 2021. So, for each month t the following regression is calculated:

$$\frac{CiC_i^t}{CiC_i^b} = \alpha + \mathrm{NC}_i\beta^{NC} + CV_i^t\beta^{CV} + \varepsilon_i, \tag{1}$$

where: CiC_i^t is *currency-in-circulation* in country i, CiC_i^b is *currency-in-circulation* in country i in the base month (i.e. February 2020), α is a constant term, NC_i is a 6-dimensional "national culture" vector for country i, CV_i^t is a 5-dimensional control variable for country i at month t, $\beta^{NC}$and β^{CV} are coefficient vectors, and ε_i is an i.i.d. random variable. The model was constructed to measure the impact the explanatory variables had on the cumulative change of the dependent variable over the one-year period.

The dependent variable—*currency-in-circulation* (CiC)—is the demand for cash measured by the nominal value of cash circulating in the economy, presented as an index of the value of CiC at the end of 12 consecutive months (starting from the beginning of the pandemic) and the value of CiC just before the COVID-19 pandemic. CiC data were mainly gathered from the IMF IFS, but for some countries, the data were supplemented with National Central Banks' (NCBs') datasets. Countries under a monetary union (e.g., the euro area) or where a foreign currency is predominantly used (e.g., Montenegro or Panama), and countries experiencing hyperinflation (e.g., Argentina or Venezuela) were excluded from further analysis because of lack or unreliability of data about CiC.

The main explanatory variables are Hofstede's dimensions of "national culture", presented as a 6-dimensional "national culture" vector (NC_i). These were obtained from Hofstede Insights consultancy, which further expanded data prepared by Hofestede et al. (2010). Data in the vector take values from 0-100, but scores must be analyzed in relation to other countries and not absolutely. It should be further noted that scores for countries were generated during long timespan, starting from data collated between 1967 and 1973. During this time culture slowly changed (e.g. people became more individualistic and less long term orientated), however, studies shown that this not necessary means that relative position between countries changed (Beugelsdijk & Welzel, 2018).

The set of control variables consists of the basic macroeconomic factors used in money demand functions (Clarida et al., 1999), viz.

Table 1
Descriptive statistics and their method of calculation.

Type	Name	Method of calculation	*Month*	(1) N	(2) Mean	(3) sd	(4) Min	(5) Max
Dependent variable	CiC	Index, *month* to base = Feb 2020	Mar 2020	58	1.04	0.05	0.91	1.24
			Apr 2020	58	1.07	0.07	0.91	1.36
			May 2020	58	1.10	0.08	0.90	1.41
			Jun 2020	58	1.11	0.08	0.90	1.38
			Jul 2020	58	1.13	0.10	0.91	1.54
			Aug 2020	58	1.13	0.09	0.91	1.37
			Sep 2020	58	1.13	0.09	0.93	1.37
			Oct 2020	58	1.14	0.09	0.92	1.38
			Nov 2020	58	1.15	0.10	0.93	1.42
			Dec 2020	58	1.20	0.12	0.96	1.55
			Jan 2021	58	1.18	0.11	1.02	1.46
			Feb 2021	58	1.18	0.10	1.02	1.45
National culture	PDI	NA	NA	58	67.17	20.29	18	100
	IDV		(fixed variable)	58	37.76	22.76	10	91
	MAS			58	47.84	18.10	5	95
	UAI			58	66.66	22.69	8	98
	LTO			58	44.72	24.96	4	100
	IVR			58	44.40	22.79	0	97
Control variables	CiC_lag	Index, *month* to base = Feb 2019	Mar 2019	58	1.00	0.02	0.94	1.05
			Apr 2019	58	1.02	0.03	0.93	1.08
			May 2019	58	1.03	0.06	0.92	1.28
			Jun 2019	58	1.03	0.05	0.90	1.16
			Jul 2019	58	1.03	0.06	0.89	1.18
			Aug 2019	58	1.04	0.06	0.90	1.21
			Sep 2019	58	1.04	0.06	0.89	1.22
			Oct 2019	58	1.05	0.06	0.92	1.22
			Nov 2019	58	1.06	0.06	0.91	1.21
			Dec 2019	58	1.11	0.08	0.95	1.32
			Jan 2020	58	1.08	0.06	0.94	1.26
			Feb 2020	58	1.08	0.07	0.93	1.30
	GDP	Index, *month* to base = Feb 2020	Mar 2020	58	0.96	0.03	0.87	1.03
			Apr 2020	58	0.93	0.08	0.69	1.18
			May 2020	58	0.92	0.11	0.59	1.28
			Jun 2020	58	0.95	0.12	0.60	1.32
			Jul 2020	58	1.00	0.12	0.70	1.30
			Aug 2020	58	1.06	0.13	0.78	1.39
			Sep 2020	58	1.10	0.15	0.82	1.50
			Oct 2020	58	1.14	0.17	0.84	1.72
			Nov 2020	58	1.15	0.17	0.84	1.80
			Dec 2020	58	1.13	0.14	0.84	1.66
			Jan 2021	58	1.07	0.08	0.82	1.31
			Feb 2021	58	1.05	0.07	0.81	1.28
	CPI	Index, *month* to base = Feb 2020	Mar 2020	58	1.00	0.01	0.99	1.01
			Apr 2020	58	1.00	0.01	0.96	1.04
			May 2020	58	1.00	0.02	0.96	1.06
			Jun 2020	58	1.00	0.02	0.97	1.07
			Jul 2020	58	1.01	0.02	0.97	1.08
			Aug 2020	58	1.01	0.02	0.97	1.07
			Sep 2020	58	1.01	0.02	0.97	1.09
			Oct 2020	58	1.02	0.03	0.98	1.10
			Nov 2020	58	1.02	0.03	0.97	1.12
			Dec 2020	58	1.02	0.03	0.98	1.14
			Jan 2021	58	1.03	0.03	0.98	1.16
			Feb 2021	58	1.03	0.04	0.99	1.17
	IR	Average, on the period from Feb 2020 to *month*	Mar 2020	58	3.69	3.69	-0.75	15.25
			Apr 2020	58	3.52	3.63	-0.75	15.00
			May 2020	58	3.38	3.58	-0.75	14.88
			Jun 2020	58	3.30	3.55	-0.75	14.80
			Jul 2020	58	3.21	3.51	-0.75	14.75
			Aug 2020	58	3.15	3.48	-0.75	14.71
			Sep 2020	58	3.10	3.46	-0.75	14.69
			Oct 2020	58	3.06	3.44	-0.75	14.67
			Nov 2020	58	3.04	3.45	-0.75	14.65
			Dec 2020	58	3.03	3.47	-0.75	14.64
			Jan 2021	58	3.03	3.49	-0.75	14.63
			Feb 2021	58	3.01	3.50	-0.75	14.62
	SI	Average, on the period from Feb 2020 to *month*	Mar 2020	58	28.43	10.59	2.42	78.26

(*continued on next page*)

Table 1 (*continued*)

Type	Name	Method of calculation	*Month*	(1) N	(2) Mean	(3) sd	(4) Min	(5) Max
			Apr 2020	58	45.23	9.23	11.14	72.24
			May 2020	58	52.26	9.55	16.22	72.85
			Jun 2020	58	54.31	10.15	19.28	73.98
			Jul 2020	58	55.13	10.86	21.31	74.69
			Aug 2020	58	55.77	11.37	22.76	76.32
			Sep 2020	58	55.87	11.73	23.85	76.96
			Oct 2020	58	55.71	11.92	24.76	77.46
			Nov 2020	58	55.86	11.83	25.76	77.97
			Dec 2020	58	56.20	11.73	25.18	75.29
			Jan 2021	58	56.62	11.69	24.87	73.49
			Feb 2021	58	56.88	11.64	23.77	74.38

Note: Variables presented in column "name" are: CiC—currency-in-circulation, PDI—the power distance index, IDV—the index of individualism, MAS—the index of masculinity, UAI—the uncertainty avoidance index, LTO—the index of long-term orientation, IVR—the index of indulgence, GDP—gross domestic product, CPI—consumer price index, IR—interest rates, SI—COVID-19 Stringency Index. With the notable exception of the "national culture" variables, all data were calculated independently using the formula presented in the column "method of calculation." The sources of the data used in the calculations are presented in Table 2.

GDP, interest rates (IR), and CPI. These data were collected from various sources, primary from the BIS and IMF IFS databases, but—whenever any data were missing—they were obtained, if possible, directly from NCBs or National Statistical Offices (NSOs). The above variables were complemented by: (i) a one-year lag in CiC, to account for country-specific trends and seasonality; and (ii) the COVID-19 Stringency Index (SI), collected from Oxford COVID-19 Government Response Tracker, which tracks the strictness of governments policies that restrict people's behavior (like lockdowns) (Hale et al., 2021).

Since the study was conducted using monthly data, quarterly GDP data were temporally disaggregated using the Denton-Cholette method (Cholette, 1984) without an indicator series (since it proved impossible to find one for such a divergent set of countries). Additionally, it should be noted that IR data were compiled with a hierarchy suggested by the monetary transmission mechanism (Taylor, 1995). Specifically, precedence in descending order, was given to "central bank policy rates", "money market rates", then "deposit rates", depending on availability. SI data were converted from daily to monthly by averaging the value of the index for a given month.

All control variables were transformed similarly to the dependent variable. The CiC lag, GDP, and CPI data for specific months were divided by the base month ($\frac{CiC_i^{t-12}}{CiC_i^{b-12}}$, $\frac{GDP_i^t}{GDP_i^b}$, and $\frac{CPI_i^t}{CPI_i^b}$ respectively). In turn, IR and SI data were averaged over the period from the base month to the consecutive month for each country ($\frac{\sum_{\tau=b}^{t} IR_\tau}{\tau-b+1}$ and $\frac{\sum_{\tau=b}^{t} SI_\tau}{\tau-b+1}$ respectively). The base month was set to be February 2019 for CiC lag and February 2020 for the other control variables (similarly to dependent variables).

Table 1 presents descriptive statistics of the variables used in the study, whereas detailed variable sources are presented in Table 2.

3. Results and discussion

All twelve models are presented in Table 3 and Fig. 1 holds summarization of "national culture" coefficient values and how they varied model-to-model. Generally, the results show that people in countries with a high UAI experienced a statistically significantly higher increase in the demand for physical money, as hypothesized. This may be associated with precautionary demand, as it has already been shown by Leland (1968) that this motive is positively related with higher uncertainty. Additionally, it is suggested by fact that the growth of value of *currency-in-circulation* in many countries was driven mainly by increase in volumes of banknotes with largest denomination (Rösl & Seitz, 2021), which also is an indicator of such motive (Assenmacher et al., 2019; Bech et al., 2018).

The increase of quantity of physical money happened also in societies with higher IVR. This increase in demand may be linked with transactional demand, especially in countries in which cash usage is high. The significance of this increase is apparent at the end of the analyzed period, when initial fears had abated and myths about contracting the virus as a result of handling cash had been debunked (Tamele et al., 2021). PDI, IDV, and LTO were only found to be significant in singular regressions, while MAS was found to be insignificant altogether.

Several additional control variables were considered when constructing the model. These included ATMs per capita, the proportion of people owning debit or credit cards, and the proportion of people that had made digital payments in the recent past. All these variables were obtained from the World Bank's Global Findex Database (Demirgüç-Kunt et al., 2018). They all proved to be insignificant, although this might partly be explained by the significant gap between the time of this study mostly 2020—and the time of the World Bank study—2017. Another type of data that was considered was data on trust in banks. These were obtained from the 7th Wave of World Values Survey (Haerpfer et al., 2022). However, these data restricted the sample to only about 30 countries and interfered with the significance of UAI. These facts, plus the additional fact that the same 30 countries had similar results to the one presented above, may be due to the fact, demonstrated by Ahunov and Van Hove (2020a), that UAI and bank trust are closely related phenomena.

Furthermore, to ensure that the increase in foreign demand for safe-haven currencies (e.g. USD, EUR), which could be as much as 50% (Judson, 2017; Lalouette et al., 2021), did not skew the results, countries that issued these currencies were excluded in further robustness checks. As the euro area countries had already been excluded from the study, the three currencies that were chosen were the

Table 2
Detailed variables sources.

Country	CiC	PDI	IDV	MAS	UAI	LTO	IVR	GDP	CPI	IR	SI
ALB	IMF	Hofstede Insights						IMF	IMF	IMF	OxCGRT
AUS	IMF							IMF	BIS	BIS	
AZE	IMF							NSO	IMF	IMF	
BFA	IMF							NSO	IMF	IMF	
BGR	IMF							IMF	BIS	IMF	
BIH	IMF							IMF	IMF	IMF	
BLR	IMF							IMF	IMF	IMF	
BOL	IMF							NSO	IMF	IMF	
BRA	IMF							IMF	BIS	BIS	
CAN	IMF							IMF	BIS	BIS	
CHE	NCB							IMF	BIS	BIS	
CHL	IMF							IMF	BIS	BIS	
CHN	NCB							IMF	BIS	BIS	
COL	IMF							IMF	IMF	BIS	
CPV	IMF							NSO	IMF	IMF	
CZE	IMF							IMF	BIS	BIS	
DNK	IMF							IMF	BIS	BIS	
DOM	IMF							NSO	IMF	IMF	
DZA	IMF							IMF	BIS	IMF	
EGY	IMF							NSO	IMF	IMF	
GBR	NCB							IMF	BIS	BIS	
GEO	IMF							IMF	IMF	IMF	
GHA	IMF							NSO	IMF	IMF	
HKG	IMF							IMF	BIS	BIS	
HRV	IMF							IMF	BIS	NCB	
HUN	IMF							IMF	BIS	BIS	
IDN	IMF							IMF	BIS	BIS	
IND	NCB							IMF	BIS	BIS	
ISL	IMF							IMF	BIS	BIS	
JOR	IMF							NSO	IMF	IMF	
JPN	IMF							IMF	BIS	BIS	
KAZ	IMF							NSO	IMF	IMF	
KOR	IMF							IMF	BIS	BIS	
MAR	IMF							NSO	IMF	IMF	
MDA	IMF							NSO	IMF	IMF	
MEX	IMF							IMF	BIS	BIS	
MYS	IMF							NSO	BIS	BIS	
NGA	IMF							NSO	NSO	IMF	
NOR	IMF							IMF	BIS	BIS	
NZL	IMF							IMF	BIS	BIS	
PER	IMF							NSO	BIS	BIS	
PHL	IMF							IMF	BIS	BIS	
POL	IMF							IMF	BIS	BIS	
PRY	IMF							IMF	IMF	IMF	
ROU	IMF							IMF	BIS	BIS	
RUS	IMF							IMF	BIS	BIS	
SAU	NCB							IMF	BIS	BIS	
SGP	NCB							IMF	BIS	IMF	
SRB	IMF							IMF	BIS	BIS	
SWE	NCB							IMF	BIS	BIS	
THA	IMF							IMF	BIS	BIS	
TUR	IMF							IMF	BIS	BIS	
TWN	NCB							NSO	NSO	NCB	
TZA	IMF							NSO	IMF	IMF	
UKR	IMF							IMF	IMF	IMF	
URY	IMF							NSO	IMF	IMF	
USA	NCB							IMF	BIS	BIS	
ZAF	IMF							IMF	BIS	BIS	

Note: Each row shows the origin of the data used in this study. The first column, "country", shows name of the country, encoded as 3-letter ISO code, for which data were collected. Following columns successive variables: CiC—currency-in-circulation, PDI—the power distance index, IDV—the index of individualism, MAS—the index of masculinity, UAI—the uncertainty avoidance index, LTO—the index of long-term orientation, IVR—the index of indulgence, GDP—gross domestic product, CPI—consumer price index, IR—interest rates, SI—COVID-19 Stringency Index. As for sources of information: IMF stands for International Monetary Fund's International Financial Statistics; BIS—Bank for International Settlements; NCB—respective National Central Bank; NSO—respective National Statistical; OxCGRT—Oxford COVID-19 Government Response Tracker.

Table 3
Estimation output of OLS regressions. Dependent variable: *CiC*.

	(1) Mar 2020	(2) Apr 2020	(3) May 2020	(4) Jun 2020	(5) Jul 2020	(6) Aug 2020	(7) Sep 2020	(8) Oct 2020	(9) Nov 2020	(10) Dec 2020	(11) Jan 2021	(12) Feb 2021
Constant	0.7586	0.9864	0.4842	-0.4094	-0.2741	-0.1205	-0.1150	-0.1666	-0.1853	-0.2939	0.2662	0.3668
	(1.6301)	(0.7613)	(0.8297)	(1.2600)	(1.5373)	(1.2068)	(0.8399)	(0.7099)	(0.6947)	(0.7642)	(0.8072)	(0.7367)
PDI	0.0010**	0.0006	0.0005	0.0007	0.0006	0.0008	0.0006	0.0008	0.0012	0.0012	0.0018*	0.0019*
	(0.0004)	(0.0008)	(0.0008)	(0.0008)	(0.0009)	(0.0008)	(0.0008)	(0.0008)	(0.0009)	(0.0010)	(0.0010)	(0.0011)
IDV	0.0008**	0.0007	0.0007	0.0009*	0.0008	0.0009	0.0007	0.0006	0.0007	0.0002	0.0005	0.0006
	(0.0003)	(0.0004)	(0.0005)	(0.0005)	(0.0007)	(0.0006)	(0.0006)	(0.0007)	(0.0006)	(0.0007)	(0.0007)	(0.0007)
MAS	0.0000	-0.0001	-0.0001	-0.0001	-0.0001	-0.0003	-0.0002	0.0000	0.0001	0.0003	0.0000	-0.0002
	(0.0002)	(0.0003)	(0.0003)	(0.0005)	(0.0006)	(0.0005)	(0.0005)	(0.0005)	(0.0005)	(0.0006)	(0.0006)	(0.0006)
UAI	0.0008***	0.0011***	0.0013***	0.0015***	0.0016***	0.0018***	0.0016***	0.0015***	0.0014**	0.0015***	0.0019***	0.0020***
	(0.0003)	(0.0004)	(0.0004)	(0.0004)	(0.0005)	(0.0005)	(0.0006)	(0.0005)	(0.0005)	(0.0006)	(0.0006)	(0.0006)
LTO	-0.0007*	-0.0006	-0.0005	-0.0003	-0.0006	-0.0004	-0.0004	-0.0005	-0.0005	-0.0007	-0.0012**	-0.0008
	(0.0003)	(0.0004)	(0.0004)	(0.0005)	(0.0006)	(0.0005)	(0.0005)	(0.0005)	(0.0006)	(0.0006)	(0.0006)	(0.0006)
IVR	0.0005**	0.0006	0.0007	0.0006	0.0008	0.0010*	0.0011**	0.0013**	0.0015***	0.0017***	0.0018***	0.0016**
	(0.0002)	(0.0004)	(0.0005)	(0.0006)	(0.0008)	(0.0006)	(0.0005)	(0.0005)	(0.0005)	(0.0005)	(0.0006)	(0.0006)
CiC_lag	0.9040**	0.7734*	0.6482**	0.2870	0.3826	0.3519	0.3763	0.4667**	0.4548**	0.5541**	0.1046	0.0645
	(0.4451)	(0.3940)	(0.2788)	(0.3459)	(0.3616)	(0.2672)	(0.2253)	(0.2084)	(0.2228)	(0.2437)	(0.2651)	(0.2647)
GDP	0.0751	-0.0411	-0.0460	-0.0488	0.0819	0.0714	0.1126	0.0998	0.0965	0.1458	0.4884*	0.5716*
	(0.1966)	(0.1163)	(0.0920)	(0.1063)	(0.1929)	(0.1247)	(0.1063)	(0.0877)	(0.0810)	(0.1192)	(0.2822)	(0.2935)
CPI	-0.8706	-0.8896	-0.3037	0.9572	0.6315	0.4547	0.3991	0.3855	0.4046	0.3768	-0.0985	-0.2465
	(1.4955)	(0.6913)	(0.6859)	(1.0387)	(1.1852)	(0.9960)	(0.7259)	(0.6471)	(0.6433)	(0.7625)	(0.8386)	(0.7225)
IR	-0.0004	0.0037	0.0032	-0.0006	0.0025	-0.0009	-0.0017	-0.0012	-0.0020	-0.0044	-0.0050	-0.0037
	(0.0021)	(0.0045)	(0.0041)	(0.0049)	(0.0056)	(0.0061)	(0.0058)	(0.0064)	(0.0074)	(0.0075)	(0.0075)	(0.0076)
SI	0.0011*	0.0018**	0.0026***	0.0023**	0.0019*	0.0024**	0.0025**	0.0020*	0.0016	0.0016	0.0018	0.0019
	(0.0006)	(0.0008)	(0.0010)	(0.0010)	(0.0011)	(0.0010)	(0.0010)	(0.0011)	(0.0012)	(0.0012)	(0.0012)	(0.0011)
Observations	58	58	58	58	58	58	58	58	58	58	58	58
R-squared	0.2646	0.3470	0.4598	0.3666	0.3750	0.4497	0.4518	0.4659	0.4629	0.5348	0.4726	0.4478

Note: Do to the heteroskedasticity issues present in regressions (11) and (12) data in parentheses presents Robust Standard Errors. ***, **, * denote statistical significance at 1%, 5% and 10%, respectively.

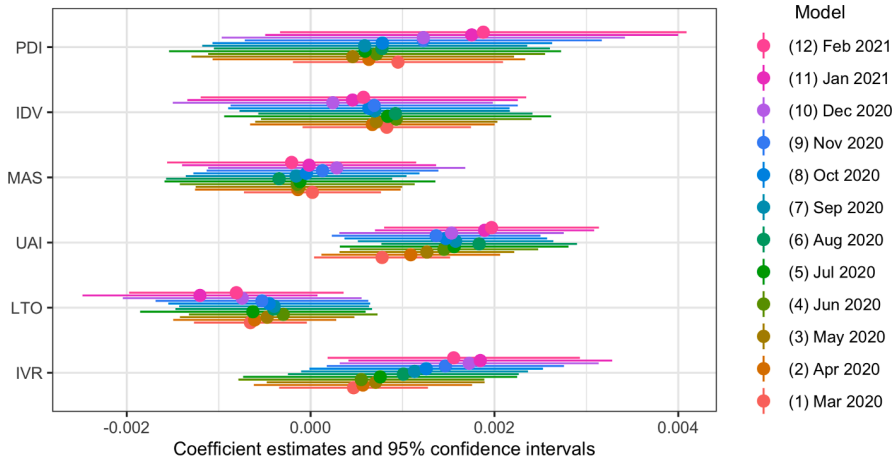

Fig. 1. National culture variables coefficient behavior summary.

US dollar, Swiss franc, and Japanese yen (Cho & Han, 2021; Hossfeld & MacDonald, 2015). There were no significant changes in the results.

Finally, it should be noted that employing the same methodology on the data from recent years proved that both UAI and IDV were only significant factors in occasional regressions.

4. Findings and conclusions

This study shows that some aspects of "national culture", e.g. UAI, and IVR, impacted the demand for cash during the COVID-19 pandemic. This suggests that these same factors also affected the decisions of individuals during previous crises and may well do likewise during future ones.[a] This approach to analyses of the demand for cash might therefore be a promising avenue for further studies.

This finding also has a potential practical application. Central banks in societies that are more indulgent (especially a few months after a crisis) and, particularly, in nations where uncertainty is avoided should be prepared to fulfill a greater demand for cash during distressful times. Rumors about a lack of cash could exacerbate negative feelings, trigger coping mechanisms, and increase money demand even further, thereby resulting in a negative feedback loop and possibly causing bank runs. This in turn could undermine the stability of individual banks or the banking sector. Potential countermeasures include greater cash reserves being held by NCBs and monitoring the quality of the cash supply chain.

Authorship

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Declaration of Competing Interest

The author declares no conflict of interest.

Data availability

The data that support the findings of this study are openly available in Mendeley Data at https://data.mendeley.com/datasets/hngpw44b8z/1 (Kotkowski, 2022)

[a] While this paper was being written, the Russian invasion of Ukraine, which began in February 2022, significantly increased the demand for cash in Ukraine's non-euro area neighbors (Belarus, Hungary, Moldova, Poland, and Romania). In April 2022, the value of currency in circulation in those countries was on average 7.9% higher than in January 2022 (the month prior to the invasion). Interestingly, all these countries are characterized by an average UAI of 91 points.

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P5:
Cash usage in Poland in 2020: Insights into the role of the COVID-19 pandemic and spatial aspects

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Cash usage in Poland in 2020: Insights into the role of the COVID-19 pandemic and spatial aspects

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ABSTRACT

The study explores the factors likely to induce Polish customers to pay by cash, instead of payment cards, for goods and services they are purchasing. The basis of our investigation is microdata obtained in 2020, during the "Payment Habits in Poland in 2020" study, which was conducted by Narodowy Bank Polski (National Bank of Poland) in 2020. The analysis is performed using the two-stage Heckman approach. In the first stage, card adoption factors are analyzed using a probit model; then, in the second stage, the OLS model is employed to analyze the propensity to pay by cash, despite having a payment card. Apart from typical factors affecting the use of different payment methods, e.g., age, income, education, or perceptions about payment methods, we find an important role of two, yet under-investigated factors, namely: the COVID-19 pandemic and spatial aspects. E.g., we find that self-reported change in payment behavior during the pandemic indeed was reflected in diary studies. Furthermore, we show that instances of merchants' refusal to accept cash significantly impacted payment choices. Moreover, the results indicate significant spatial heterogeneity in payment behavior and that aspects like distance to the nearest ATM impacted cash usage, as more cash is used when ATMs are farther away, illustrating the concept of "cash burns." Lastly, it has been noticed that during the pandemic, ownership of contactless payment cards significantly reduced cash usage, most probably due to the fear of contracting the disease by physical contact with surfaces (like cash).

JEL classification: E41, D12, L81

Keywords: cash, payment cards, payment behavior, customer payment choice, Heckman approach.

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1. INTRODUCTION

It might seem that in an era of the growing adoption of financial innovation and digitalization of financial systems, analyses focused on cash use are of little relevance. Indeed, a closer look at some countries might reinforce this view, as cash use at physical points of sale can be quite low. E.g., in 2021, about 15% of all transactions in the UK (UK Finance, 2022) and 20% in the US (Cubides & O'Brien, 2022) were done via cash. Even more, in Sweden and Norway, which are at the forefront of becoming cashless countries, cash use in 2022 was reported to be even lower: 8% in Sweden (Sveriges Riksbank, 2022) and 4% in Norway (Norges Bank, 2022). However, in many economies, cash use is significantly higher and cash still plays an important role in the settlement of day-to-day purchases, e.g., according to a recent SPACE survey (ECB, 2022), 59% of all non-recurring transactions in the euro area are done this way, and its use ranges between 19% in Finland and 77% in Malta.

Notwithstanding the above and despite a worldwide declining trend of cash use for transactional purposes (Khiaonarong & Humphrey, 2023), demand for physical money has been rising for decades now (Ashworth & Goodhart, 2020). This phenomenon, now dubbed as "cash/banknote paradox" (Jiang & Shao, 2020; Pietrucha, 2021; Zamora-Pérez, 2021), was first noticed by Bailey (2009), who observed an increasing demand for high-denomination euro banknotes during the 2007–2008 financial crisis, coupled with a declining share of retail cash transactions.

Such a situation was exacerbated even further during the COVID-19 pandemic and has since received considerable attention in the literature (see, e.g., Auer et al., 2022; Caswell et al., 2020; Chen et al., 2022; Goodhart & Ashworth, 2020). Kotkowski (2023) showed that the increase in demand for cash stemmed from people's uncertainty avoidance, further linked with a precautionary motive of cash demand. This observation was in line with other recent studies that suggest that cash is being increasingly hoarded and used as a precautionary measure – according to Tamele et al. (2021) and Rösl and Seitz (2022), cash is treated as a "safe haven" during crises. Furthermore, other studies (see, e.g., Bounie et al., 2023; Jonker et al., 2022; Kotkowski & Polasik, 2021) showed that during the COVID-19 pandemic, cashless instrument use surged. One particularly important factor that affected this change has been reported to be fear of being infected by the virus while using cash (Huterska et al., 2021; Wisniewski et al., in press).

Poland is also subjected to the "cash paradox" phenomenon (studied recently by, e.g., Kaźmierczak et al. (2021) and Pietrucha and Gulewicz (2022)). Steadily increasing demand for cash in tandem with a downward trend in cash payments has been observable for years now. Table 1 shows the results of three surveys of payment habits conducted by Narodowy Bank Polski (NBP), the Polish central bank. Between 2011/2012 and 2020, the proportion of retail transactions performed by cash decreased from 81.8% to 46.4% (by volume) and 63.7% to 29.3 (by value), while the value of cash in circulation (CIC) to GDP increased by as much as 187.5% from 2011.

Table 1
Estimated share of cash transactions in the total number and value of transactions in the NBP surveys versus circulation growth rates from the end of 2011

	2011/2012	2016	2020
Share of cash in payment transactions (in %) by:			
– volume	81.8	53.9	46.4
– value	63.7	40.7	29.3
CIC growth since 2011 (in %)	–	67.5	187.5

Source: Authors' compilation based on the following studies of payment behavior: Koźliński (2013) for 2011/2012; Manikowski (2017) for 2016, and Kotkowski et al. (2021) for 2020.

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In our opinion, relatively high cash use in Poland and the above considerations vindicate the need to examine the reasons for this widespread use of cash. In this paper, we reinvestigate the main factors of cash use known in the literature, but in a situation where customers have adopted cashless instruments, e.g. payment cards. This is done by employing the Heckman approach at the respondent level to separate the stage of adopting the card from that of its use. This approach enabled unbiased and consistent estimators of the model parameters to be obtained.

Since in this paper, we use microdata obtained during a payment diary study done in 2020, that is during the COVID-19 pandemic, we are also able to further delve into the role of the pandemic on payment behavior. We deepen our understanding in a previously researched context – the role of the merchant's refusal to accept cash for payment behavior. Furthermore, thanks to the detailed survey performed together with the payment diary, we investigate another under-researched aspect of payment choice, viz. spatial aspects.

The article consists of five sections, plus references and an appendix. The second section presents an overview of the extant econometric research on the reasons for using various financial instruments. Special attention is paid to the types of econometric tools used in the research under discussion. Section three describes the data and methodology employed in the analyses. The fourth section discusses the results. The article ends with conclusions. The appendix provides estimates of econometric models for three data sets that differ in the scale of the reduction due to missing data for certain independent variables.

2. LITERATURE REVIEW

The question of why people pay in certain ways has been under investigation for several decades now (Boeschoten & Fase, 1989) and myriads of different factors have been discovered – see, e.g., Świecka et al. (2021) and Stavins (2017) for detailed discussions. The majority of analyses explaining why consumers use different payment instruments are based on data obtained through surveys and records of payments made by respondents over a certain period (these are known as diary surveys).

This enables the use of econometric tools to uncover the reasons for the use of particular instruments. Thus, for example, Borzekowski et al. (2008), using a series of probit models, analyzed the use of debit cards in the US. Among the many influential factors, they identified the demographic makeup and financial situation of the respondents. By contrast, Borzekowski and Kiser (2008) focused on debit cards, credit cards, checks, and cash in the US. They used a characteristics-based rank-order logit model to quantify consumer substitution between payment methods. Arango, Huynh, and Sabetti (2015) used a multinomial logit model to analyze the use of cash, debit, and credit cards at points of sale.

Arango, Hogg, and Lee (2015) focused their analysis on individuals with access to both debit cards and credit cards and abstracted from issues regarding payment instrument adoption. They used a probit model for this purpose. On the other hand, Wakamori and Welte (2017) modeled payment choice on a generalized logit model. This allowed them to account for the observed heterogeneity of the data and focus on determining whether consumers do prefer to use cash or whether merchants discourage the use of cards for small transactions. In turn, Stavins (2018) analyzed the influence of consumer preferences on specific payment instruments and how price discounts and surcharges based on the payment method affect payment instrument choice. For this purpose, the author used transaction-level probit regressions.

The analyses discussed so far primarily used discrete-choice models, e.g., logit and probit, to determine the probability of using different kinds of payment instruments at the transaction level. However, the literature also describes a slightly different approach: one that assumes a two-stage use of payment instruments and that can be adopted on either respondent level or transaction level

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– the so-called "Heckman correction" (Heckman, 1976, 1979). The first stage of this approach describes the adoption of the instrument, while the second stage describes its use.

For example, Koulayev et al. (2016) developed a structural model of adoption and use of payment instruments, where consumers select payment instruments to adopt in stage 1, and then decide on how to use them in stage 2. The same approach was used by Schuh and Stavins (2010, 2013). They proved that the characteristics of payment instruments are the most important determinants of instrument use by estimating econometric models of consumer adoption (extensive margin) and the use (intensive margin) of seven payment instruments. By contrast, Trütsch and Marcotty-Dehm (2021), using a two-step Heckman model, focused primarily on the impact of financial literacy on payment behavior. They used data from a payment diary and an online survey conducted in Switzerland in 2018.

One of the most recent analyses available in the literature was carried out on eurozone countries by Kajdi (2022). Three main research areas were investigated: (i) the socioeconomic characteristics (that can be associated with financial inclusion), (ii) the factors behind consumers' payment choices, and (iii) the underlying factors for holding cash in a wallet. To this end, the author used the data from the SPACE survey which was conducted by the ECB in 2019 and implemented the Heckman approach at both the transaction and respondent levels.

In most of the studies described above, several characteristics were considered to explain payment behavior among consumers. These can be grouped as follows: (i) socioeconomic characteristics (mainly age, income, education, gender, and employment status) and (ii) the specific features of the transaction environment. Heckman's respondent-level approach typically did not include payment characteristics (such as transaction value, the type of good or service purchased, card acceptance by a merchant, day of the week, etc.) or the importance/usefulness of the different attributes of payment instruments (mainly ease of use, record keeping, security, budget control). In the case of payment cards, a set of variables quantifying the characteristics of the debit and credit card plans people have when they begin to complete the diary was sometimes considered. By contrast, when a location was considered, only its nature (rural or urban) was taken into account. Many analyses additionally factored in on-hand cash holdings at the beginning of the diary study. The Internet access status was also considered in many analyses.

The vast majority of these analyses confirm the fact that cash is used more often by the elderly and by people with lower educational and/or income levels. Furthermore, those who do not use cash for daily transactions tend to keep less of it in their wallets, while those who indicate a preference for cash payments or who claim to place greater importance on cash payment options are more likely to carry more of it.

3. METHODOLOGY AND DATA

3.1. Data

This paper uses data obtained during a study entitled "*Payment Habits in Poland in 2020*", which was conducted by Narodowy Bank Polski in 2020 (Kotkowski et al., 2021). The study was carried out on a representative sample of 1,265 respondents from September 15 to October 15, 2020 (i.e., during the COVID-19 pandemic but between waves). The study consisted of a survey (completed using the CAPI method) and a 3-day payment diary (completed using the PAPI and CAWI survey methods).

The payment diary recorded 3,759 retail transactions having a total value of PLN 258 291.26 (approx. USD 66,240.42). Approximately 88% of these were performed by respondents who had a payment card and 82% were performed in places with an installed payment terminal. The

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division of registered transactions in our sample with respect to payment card ownership and the presence of EFT-POS (payment) terminals is presented in Table 2.

These characteristics can be assessed as representative of the Polish economy, as at the end of 2020 payment card ownership in Poland was approx. 81.7%, with 38.7m payment cards issued to individuals in Poland (1.01 cards per capita). Furthermore, about 1m payment terminals (approx. 27 payment terminals per thousand people) were being operated by 458,000 merchants. According to POLASIK Research, a consulting agency, approx. 43% of merchants accepted payment cards in Poland in 2019. However, it is estimated that only about 14% of all cash transactions were completed with merchants that did not accept payment cards (Polasik et al., 2020).

Table 2
Card ownership and EFT-POS terminal presence among registered transactions

		Payment card ownership		Sum
		Yes	No	
EFT-POS terminal presence	Yes	2,795	283	3,078
	No	401	92	493
	Don't know	125	63	188
Sum		3,321	438	3,759

Source: Based on Kotkowski et al. (2021).

As the analyses in the present article are concerned with choosing between cash and payment cards, data on payments made with other payment instruments were excluded. Of the 3,759 transactions mentioned, only 26 were concluded with payment instruments other than cash or payment card. These were performed by seven respondents who did not use either cash or a payment card during the diary survey. The restriction to cards and cash reduced the number of diary survey respondents from 991 to 984 (i.e., a 0.71% reduction). These 984 respondents constituted the first of three data sets (Dataset 1) subjected to econometric analysis. Further data sets were constructed by the exclusion of respondents that had not provided the data about the time that was needed for them to reach the nearest ATM (reduction to 929 respondents; Dataset 2) or had not assessed their payment instrument perceptions (reduction to 921 respondents; Dataset 3). A summary of all three data sets is presented in Table 3.

Table 3
Data sets subjected to econometric analysis

Type of data	Sample size R = respondents T = transactions	The amount of reduction in relation to base data	
		pcs.	%
Base data All respondents	R = 991 T = 3,759	–	–
Dataset 1 No transactions other than cash and card	R = 984 T = 3,733	6	0.71
Dataset 2 with *minutes to closest ATM*	R = 929 T = 3,579	62	6.26
Dataset 3 with *minutes to closest ATM* and variables describing perceptions about cash and payment cards	R = 921 T = 3,561	67	6.76

Source: Authors' calculation.

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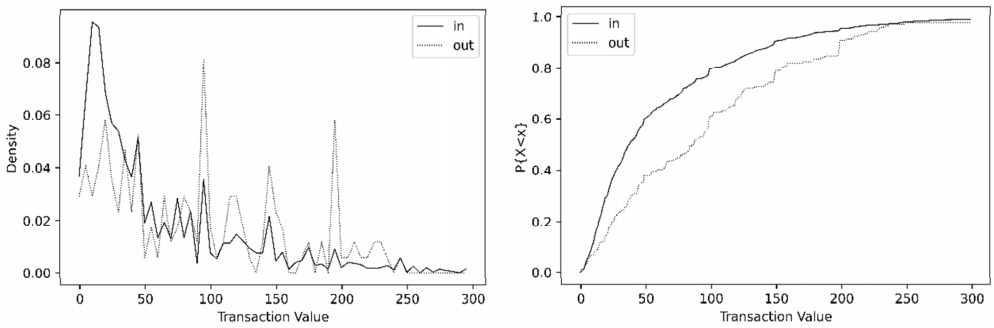
To determine whether these reductions are random, the concept of Missing Completely at Random (Wakamori & Welte, 2017) was used. For this purpose, it was decided to analyze the value of transactions as one of the most important factors influencing the decision to use cash at points of sale. The probability density and distribution $P\{X < x\}$ were determined for both the excluded and resulting data. These are shown in Figure 1.

Figure 1
Probability density function (on the left side) and probability distribution $P\{X < x\}$ (on the right side) of the variable transaction value for deleted (out) and post-deleted (in) data (transaction-level analysis)



Source: Authors' calculation.

Figure 1 illustrates the differences in the distributions of the transaction values in the two data sets (out and in). There are more large cash transactions in the deleted data sets. The two-sample Kolmogorov-Smirnov test proved that the sample data sets (remaining and deleted) do not come from the same distribution (test statistic $D = 0.2577$, p-value $= 4.28 \cdot 10^{-10}$). At the very least, this suggests the presence of what is known as Missing at Random (MAR).

MAR means that the propensity for a data point to be missing is not related to the missing data but to some of the observed data (e.g. the *TRX value*). This, in turn, can lead to obtaining overestimates for smaller transactions and underestimates of cash probabilities for larger transactions. However, due to the size of the reduction (less than 7%), the scale of the possible burden should not be significant. This is analyzed below.

The analyses assume that every respondent has cash or can obtain it relatively easily. This assumption is justified by the statistics of the data from the diary survey. Using the imputation techniques of Roystone (2009), a *cash-holding status* variable was determined. A respondent is assumed to be in possession of cash if at least one of the following conditions is met:

– the respondent had cash at the beginning of the survey according to the diary;
– the respondent withdrew cash during the survey and noted this in the diary;
– the respondent made at least one cash payment and recorded this in the diary.

When cash holding status was defined this way, only 19 (0.5%) of the 3,759 retail transactions were performed by respondents that did not possess cash, and this only concerned 5 respondents (0.5%). Therefore, if the Datasets were further truncated by excluding those respondents who did not have cash, the reduction would be too small to significantly affect the estimates. Because of that, we abstained from further truncation.

3.2. Model

To obtain the results presented in the paper, we used a two-step approach invented by Heckman and originally implemented for wage equations at the microdata level. Heckman (1979, p. 160) considered such a calculated estimator as useful for "*provid(ing) good starting values*

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for maximum likelihood estimation". Later papers criticized some features of Heckman's two-step approach (see Puhani, 2000), like:

– Heckman estimators are inefficient and subsample OLS may be more robust;
– a high correlation between the exogenous variables in the selection and the use model often exists in the selection problems, which may cause the collinearity between the inverse Mills ratio and the other regressors, which may impact the robustness of estimators. Therefore, it is indicated to investigate whether there are collinearity problems in the data.

Notwithstanding the above critique, we use a two-step Heckman approach to analyze each of the three defined Datasets. The first step describes the adoption of card payment in the form of a probit model with a binary dependent variable A_{ij} of the following form:

$$A_{ij} = \begin{cases} 1 \text{ if consumer } i \text{ has adopted card payment} \\ 0 \text{ otherwise} \end{cases} \tag{1}$$

The second step describes the use (intensity) of cash under the form of an OLS model with a continuous dependent variable U_{ij} denoting the proportion of each i-th individual's payments made in cash.

The two-step Heckman approach resulted in the following models:

$$P(A_i = 1) = A\left(\mathbf{X}_i^1\right) + \varepsilon_i^A - \text{adoption (selection) model} \tag{2}$$

$$U_i = U\left(\mathbf{X}_i^2, MR_i^{-1}\right) + \varepsilon_i^U - \text{use (regression) model} \tag{3}$$

where $\mathbf{X}_i^1$ means a set of explanatory variables expressing the factors with impact on card possession (adoption), $\mathbf{X}_i^2$ means a set of explanatory variables expressing the factors with impact on cash choice (use), ε_i^U and ε_i^A mean errors terms. In the use model, there is MR_i^{-1} which means the inverse Mills ratio (named later as a *lambda*) obtained for the first model. As long as ϵ_i^A has a normal distribution and ϵ_i^U is independent of the inverse ratio MR_i^{-1}, Heckman's two-step estimator is consistent (see, e.g., Puhani, 2000).

The following elements of the set $\mathbf{X}_i^1$ can be distinguished: *DEMOGRAPHICS*, *ECONOMY,* and *LOCATION*. *DEMOGRAPHICS* includes gender, age, education, and financial knowledge. Financial knowledge was assessed using the Big Three questions (Mitchell & Lusardi, 2011). The *ECONOMY* feature group includes income and economic activity. The *LOCATION* group considers two spatial aspects. The first distinguishes between rural areas and different-sized places of residence. The second takes into account the administrative division of Poland into 16 provinces.

The variables from the set of $\mathbf{X}_i^2$, determining the choice of cash as an instrument for making payments for goods and services by cash at points of sale (POS), not only included variables from the $\mathbf{X}_i^1$ set, but also from the *FACTORS AT THE POS*, *PORTFOLIO FEATURES*, *COVID VARIABLES*, and *PERCEPTIONS* classes. The *FACTORS AT THE POS* set includes transaction characteristics (e.g. average transaction value and the type of goods purchased) and a Boolean variable indicating the presence of a payment terminal that allows payment card transactions. It should be noted that, unlike other types of data, *FACTORS AT THE POS* were determined based on diaries recording individual payment transactions.

Let's discuss the legitimacy of using variables as instruments in the use model grouped into the before-mentioned classes. The first class (*FACTORS AT THE POS*) of variables refers to factors like *TRX value*, *TRX place type*, and *POS terminal*. These variables are strictly related to payments (were collected during the diary survey) and therefore it seems that they should not influence the decision regarding payment card adoption. However, the question is whether the consumption structure of an individual (expressed by the variables) can affect their decision to

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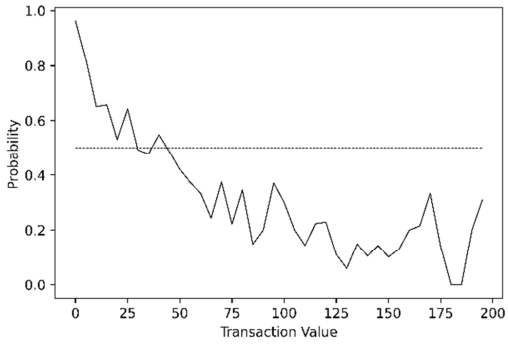
adopt a payment card or whether there is an inverse relationship. We assumed a one-way relation: from the adoption to the consumption structure. The variable of *TRX value* is one of the more important characteristics of this group, and other studies show that it significantly influences the decision of whether to pay by cash (see, e.g., Świecka et al., 2021). The distribution of this variable was used above to examine the nature of the reduction in the Datasets. The analysis of the frequency of cash use shown in Figure 2 confirms that the value of POS transactions can influence the choice of payment instrument. The results show that transactions not exceeding PLN 25 are more likely to be performed by cash than by payment cards. According to the 2016 survey, the threshold was PLN 46 (Manikowski, 2017). The presence of payment terminals is another variable belonging to the *FACTORS AT THE POS* set. It should be noted that this variable is vulnerable to the risk of endogeneity. As shown by Arango, Huynh, et al. (2015), individuals who prefer to use cards may choose to frequent establishments that are more apt to accept them. Consequently, the extent to which card acceptance affects the probability of using cards at low-value transactions may have been underestimated, and conversely, the probability of using cash overstated.

Figure 2
Cash payment frequencies



Note: Cash payment frequencies for the transactions to 200 zlotys. These frequencies were calculated based on a sample of 3,759 transactions in the diary without the use of weights.

Source: Authors' calculation.

The *PORTFOLIO FEATURES* set contains such variables of the payment instruments analyzed here as *contactless card adoption* and *minutes to closest ATM*. The use of the *minutes to closest ATM* was dictated by several considerations. First, we wanted the analyses to include the potential difficulty of accessing cash through its most important source, viz. ATMs. Second, this variable obviated the inclusion of the initial cash balance. Arango, Huynh, et al. (2015), among others, included such variables in their analyses but found that it could cause undesirable endogeneity. They argued that possessing or not possessing cash determines the marginal cost of using it; possession makes its marginal cost close to zero, while non-possession can incur the cost of acquiring it or postponing a purchase. Therefore, cash status should be one of the determinants of payment choices. However, respondents who prefer to use cash adjust their cash balances accordingly. This may suggest the presence of a two-way dependency relationship. To control for the possibility of this sort of endogeneity, Arango, Huynh, et al. (2015) used an extended version of the probit model with such exogenous variables as the number of nearby ATMs deemed highly correlated with initial cash on hand. We opted for the use of *minutes to closest ATM* instead.

However, we struggled with the question of whether to include *minutes to closest ATM* in the adoption model. On the one hand, the findings of Beckmann et al. (2018) revealed that households without a bank account in Central, Eastern, and Southeastern Europe countries were significantly farther away from bank branches (2.8 km) compared to households with a bank account (2.1 km),

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which suggests that a shorter distance to bank branches may encourage households to establish a formal relationship with banks (such as having an account or taking out loans) and further this correlation implies a potential causality between access to cash (or cash services in general) and account (and consequently card) ownership. On the other hand, we suffered from a significant lack of data for this variable – 133 out of 921 respondents from the Dataset 3 set did not provide an answer regarding the distance to a close ATM. Consequently, the sample size would be reduced from 921 to 788. Ultimately, we decided to exclude this variable from the adoption model and only use it in the use model.

Contactless card adoption shows whether the respondent owns a payment card that allows NFC (proximity) payments. On the one hand, this feature – already the subject of other research (see, e.g., Brown et al., 2022; Polasik et al., 2012, 2013; Trütsch, 2020) – is very common in Poland (during the time of the study, about 92% of all issued cards and 100% of EFT-POS had such characteristic); on the other hand, emphasis on using contactless payments might have been present during the COVID-19 pandemic, as a remedy for fear associated with the risk of contracting the disease during cash handling or even manual payment card usage (Wisniewski et al., in press).

The next set of variables – *COVID VARIABLES* – covers two aspects of the COVID pandemic: (i) changes in payment behavior during the COVID-19 pandemic [*COVID change behavior*] and (ii) experience of problems with cash payments at the POS, e.g., refusal from merchant [*problem with cash payments*]. The main objective of the *COVID change behavior* variable is to measure whether respondents' opinion about their change of behavior was consistent with their actions. In turn, measuring the effect that p*roblem with cash payments* could have on payment behavior might bring important policy implications. Furthermore, it seems that adding the *COVID VARIABLES* class only to the use model does not raise any doubts. For example, *COVID change behavior* expresses the change in the payment behavior of respondents because of the pandemic without any impact on card adoption. Even if the pandemic affected the account holding, the effects of this impact would be visible only after some time. A similar explanation applies to the *problem with cash payments* variable.

The set of attributes called *PERCEPTIONS* consists of five method-of-payment *CHAR* attributes, viz. time taken to make a payment, cost of making a payment, ease of making a payment, the safety of using a particular payment method, and the perceived range of acceptance of a payment method. The econometric analyses used indicators of *RCHAR* as relative ratings of the above *CHAR* attributes calculated for each *i-th* respondent according to the following formula (Schuh & Stavins, 2010):

$$RCHAR_{kji} = \frac{CHAR_{kji}}{\sum_{l=1}^{m} CHAR_{kli}} \tag{4}$$

where the subscript k specifies the payment instrument attribute number of the set {time, easy, safe, cost, widespread}, and the subscript j specifies the payment instrument number from the set {cash, card}. However, it should be noted that since we had doubts about the credibility of the data collected among respondents without cards, viz. whether the person who does not have any card knows the real benefit of the card, we used this data only in the use model, and not for the adoption model. Our decision was further backed by the fact that we lacked 80 values of the perceptions variables, which could reduce the number of observations from 921 to 841.

In Table 4, we present a list and definitions of all explanatory variables we have used in the study. Furthermore, in Table 9 (see the Appendix), we provide descriptive statistics of variables (based on Dataset 3, that is, as will be shown in the next section, the base model for our analysis).

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Table 4
Definitions of variables

Class	Variables	Definition
FACTORS AT THE POS	*TRX value*	The average value of the transaction [in PLN].
	TRX place type	Variables that show what type of payment the respondent made: for goods (trade), for services (service), or P2P.
	POS terminal	A binary variable capturing whether the respondent noticed the payment terminal during the transaction (1) or not (0).
PORTFOLIO FEATURES	*contactless card adoption*	A binary variable capturing whether the payment card owned by the respondent was contactless (1) or not (0).
	minutes to closest ATM	Self-reported average time required by the respondent to reach the closed ATM [in minutes].
COVID VARIABLES	*COVID change behavior*	Dummy variables that capture the self-reported change in the payment behavior of the respondent during the COVID-19 pandemic: yes, towards cashless; yes, towards cash; no change.
	problem with cash payments	Dummy variables capturing the self-reported experience of the respondent of not accepting cash by the merchant during the COVID-19 pandemic: yes, often; yes, rarely; no.
PERCEPTIONS	*cash faster*	Time of use: relative assessment of cash vs. card.
	cash easy	Ease of use: relative assessment of cash vs. card.
	cash safe	Safety: relative assessment of cash vs. card.
	cash cheap	Costs: relative assessment of cash vs. card.
	cash widespread	Acceptance: relative assessment of cash vs. card.
DEMOGRAPHICS	*female*	A binary variable that captures whether the respondent was female (1) or otherwise (0).
	age	Dummy variables capturing age categories: 18–24; 25–39; 40–64; 55–64; 65+.
	education	Dummy variables capturing the respondent's level of formal education: primary, lower secondary, or no education; basic vocational or professional; secondary; higher.
	financial knowledge	Dummy variables that capture the financial knowledge of the respondent: low; average; high.
ECONOMY	*income*	Dummy variables that capture the respondent's disposable and discretionary income (in PLN): ≤1300; 1301–1800; 1801–2400; 2401–3800; >3800 PLN; refuse or do not know.
	economic activity	Dummy variables capturing the respondent's activity: employment; student; stay at home; unemployed; retired; self-employed.
LOCATION	*type of region*	Dummy variables capturing the size of the location where the respondent lives: rural area; suburban area (formally a "village", but within 20 km from a city of size greater than 100,000 inh.); small towns (fewer than 20,000 inh.); medium-size cities (20,000–100,000 inh.); large cities (more than 100,000 inh.).
	voivodships	Respondent's place of residence within the highest-level administrative division of Poland (voivodships correspond to provinces in many other countries).

Source: Authors' preparation.

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In summary, the sets of explanatory variables for the adoption and use models are defined as follows:

$$\mathbf{X}_i^1 = \{DEMOGRAPHICS, ECONOMY, LOCATION\} \tag{5}$$

$$\mathbf{X}_i^2 = \mathbf{X}_i^1 \cup \{FACTORS\ AT\ THE\ POS, PORTFOLIO\ FEATURES, COVID\ VARIABLES\ PERCEPTIONS\} \tag{6}$$

In summary, we calculate two sets of models: adoption models and use models. Each set consists of three models. Each adoption model consists of the same variables, hidden under *DEMOGRAPHICS*, *ECONOMY*, and *LOCATION* classes. It differs, however, in the sample size (see Table 3). On the other hand, use models include variables under the following classes: *FACTORS AT THE POS*, *PORTFOLIO FEATURES* (with the notable exclusion of *minutes to closest ATM* variable in Model 1), and *COVID VARIABLES*. Model 3 is the only one that also encapsulates *PERCEPTIONS* variables.

Similarly to the analysis conducted by Koulayev et al. (2016), the weights assigned to the survey and diary data were not used for the Heckman model estimates. We feared that they could hinder the interpretation of the resulting model parameter estimates.

4. RESULTS

Heckman's approach yields two types of results. The first concerns the reasons for adopting a payment card. The second concerns the use of cash at points of sale. Respondent-level results were obtained for both. Model 3 (based on Dataset 3) was used as the basis for further discussion. The result for the remaining Dataset 1 and Dataset 2 is given in the Appendix (see Tables 11 and 12).

4.1. Adoption model

The first stage of Heckman's approach yielded an adoption model in the form of a probit model. The dependent variable is *card ownership*, which is binary and has a value of 1 for respondents with at least one payment card and 0 otherwise. The model has a relatively high pseudo-R2 value of 0.5723. The other characteristics, including the results of the chi-2 test showing the significance of the variables in the model, are shown in Table 5.

Table 5
Results of the 1st stage probit regression

Number of obs	921
LR chi2(36)	460.87
Prob > chi2	0.0000
Pseudo R2	0.5723
Log likelihood	–172.2368

Source: Authors' calculation.

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Table 6 gives the results of the *lambda* estimates as a product of *rho* and *sigma*. A positive *rho* value indicates a positive correlation between the random components ε_i^A and ε_i^U of Model 2 and Model 3 respectively. Although the p-value is 0.128, which is higher than the significance levels, it is not too far above the highest value usually adopted in analyses.

Moreover, the results for Model 2, which are presented in Table 10 (see the Appendix), show that the parameter significance levels are 0.1 and 0.05. This justifies the validity of using the Heckman approach for the analyses conducted here and enables an unconstrained and consistent parameter estimates model to be obtained.

Table 6
Lambda, *rho*, and *sigma* values

	Coeff.	StdErr.	z	P>|z|	[95% conf.	interval]
Lambda	0.0838	0.0550	1.52	0.13	–0.0241	0.1916
Rho	0.3380					
Sigma	0.2478					

Source: Authors' calculation.

Table 7 shows the estimated values of marginal effects of the characteristics that affect the decision to have a payment card. Positive values indicate a higher propensity to own a payment card, and conversely, negative values indicate a lower propensity.

Table 7
Heckman's 1st stage adoption model probit regressions (marginal effects*)). Dependent variable: *card ownership*

		Coeff.	StdErr.
female		0.0215	0.0175
age (base: 15–24)	25–39	0.0172	0.0425
	40–54	0.0284	0.0428
	55–64	–0.1264***	0.0384
	65+	–0.1586***	0.0381
education (base: high)	primary	–0.2949***	0.0569
	basic voc/prof	–0.1611***	0.0508
	secondary	–0.0708	0.0514
financial knowledge (base: high)	low	–0.0871***	0.0304
	average	–0.0540*	0.0314
income (base: >3,800)	<1300	–0.0667	0.0446
	1301–1800	–0.0299	0.0417
	1801–2400	–0.0230	0.0388
	2401–3800	–0.0090	0.0398
	refuse/don't know	–0.0660*	0.0388

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continued Table 7

		Coeff.	StdErr.
economic activity (base: self-employed)	employed	0.1108	0.0833
	student	0.0714	0.0912
	stay at home	0.0033	0.1082
	unemployed	0.5860***	0.0396
	retired	0.1235	0.0839
type of region (base: large cities)	rural	–0.0220	0.0242
	suburban village	0.0435	0.0293
	small towns	0.0252	0.0335
	medium cities	0.0457*	0.0261
voivodships (base: mazowieckie)	dolnośląskie	0.5990***	0.0405
	kuj.-pomorskie	–0.1020***	0.0366
	lubelskie	0.0659	0.0498
	lubuskie	0.6758***	0.0457
	łódzkie	0.0283	0.0510
	małopolskie	–0.0763**	0.0369
	opolskie	–0.0859	0.0552
	podkarpackie	–0.1327***	0.0407
	podlaskie	–0.1239***	0.0430
	pomorskie	–0.0738*	0.0392
	śląskie	–0.0602*	0.0333
	świętokrzyskie	–0.1730***	0.0412
	warm.-mazur.	–0.1089**	0.0440
	wielkopolskie	0.1259**	0.0621
	zachodniopom.	0.0821	0.0626
constant		3.1669***	0.9911

*) All independent variables are binary. Therefore, marginal effects measure discrete change, i.e. how predicted probabilities of having a card change as the binary variable changes from 0 to 1.

Source: Authors' calculation.

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4.1.1. Demographics

The results obtained for the variables in the *DEMOGRAPHICS* group show that the propensity to have a payment card does not differ significantly between men and women. This is not the case with the other groups.

The age groups 25–39 and 40–54 are most likely to have payment cards.

The best-educated respondents have a higher propensity to hold a payment card. This is true for both general education (*education*) and financial knowledge (*financial knowledge*). The greater the general or financial knowledge, the greater the propensity to own a card. Importantly, differences with respect to the variables removed from the model (base) are mostly statistically significant.

4.1.2. Economy

Once *income* is taken into account, it can be seen that the higher the income, the higher the propensity to have a payment card. The level of reluctance to have a card is similar for those in the lowest income bracket and those who either did not know their level of income or refused to answer this question.

As for *economic activity,* employed and retired people have a surprisingly similar propensity to have a payment card. Interestingly, they have a lower propensity than students. The lowest likelihood of having a card can be observed for stay-at-home and self-employed.

4.1.3. Location

In line with the earlier description of the variables, the adoption model also took into account the types of regions in which the respondents lived, as well as the highest-level administrative units to which they belonged (i.e. their provinces).

As expected, the likelihood of having a card increases with the size of the respondent's residential settlement. Curiously, however, the residents of large cities are slightly more likely than rural residents to have a card.

When analyzing the propensity to have a card by geography (Figure 3), it can be concluded that there is statistically significant variation. As a rule, residents of the westernmost provinces are more likely to have a card.

Figure 3
A map of Poland with a propensity to card adoption in different provinces

Source: Authors' calculation.

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4.2. Use model

The second phase of the Heckman approach yields an OLS use model. The dependent variable is the *share of cash payment* in term of volume. This is a continuous variable and takes a value in the range <0–1>. As card payment is the only alternative considered, it follows that its share is equal to 1 – *share of cashless payment*. The parameter estimates are shown in Table 8.

Table 8
Heckman's 2nd stage use model OLS regressions. Dependent variable: *share of cash payment*

		Coeff.	StdErr.
TRX value		–0.0008***	0.0002
TRX place type (base: P2P)	trade	–0.2198*	0.1244
	service	–0.1399	0.1294
POS terminal		–0.5692***	0.0497
contactless card adoption		–0.1434***	0.0463
minutes to closest ATM		0.0030**	0.0015
COVID change behavior (base: no change)	towards cashless	–0.0408*	0.0219
	towards cash	0.1423***	0.0406
problem with cash payments (base: no)	often	–0.1767***	0.0670
	rarely	–0.0815**	0.0338
perceptions of cash	cash faster	0.2355**	0.1058
	cash easy	0.0838	0.1494
	cash safe	0.1723*	0.1016
	cash cheap	0.1516	0.1321
	cash widespread	–0.1255	0.1169
female		0.0181	0.0189
age (base: 15–24)	25–39	0.0387	0.0392
	40–54	0.0912**	0.0393
	55–64	0.0644	0.0476
	65+	0.1501***	0.0461
education (base: high)	primary	0.1465*	0.0754
	basic_voc/prof	0.0584*	0.0344
	secondary	0.0379	0.0262
financial knowledge (base: high)	low	0.0119	0.0282
	average	–0.0069	0.0248

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continued Table 8

		Coeff.	StdErr.
income (base: >3800)	<1300	0.1762***	0.0609
	1301–1800	0.0554	0.0444
	1801–2400	0.0553	0.0342
	2401–3800	–0.0075	0.0298
	refuse/don't know	0.0405	0.0338
economic activity (base: self-employed)	employed	0.0830	0.0969
	student	0.0615	0.1075
	stay at home	0.3143**	0.1496
	unemployed	–0.0277	0.1747
	retired	0.1028	0.0979
type of region (base: large cities)	rural	–0.0198	0.0285
	suburban_village	–0.0418	0.0339
	small_towns	–0.0194	0.0312
	medium cities	0.0263	0.0270
voivodships (base: mazowieckie)	dolnośląskie	0.0894*	0.0530
	kuj.-pomorskie	–0.0393	0.0464
	lubelskie	0.0093	0.0476
	lubuskie	0.2332***	0.0528
	łódzkie	0.0101	0.0459
	małopolskie	–0.0713*	0.0432
	opolskie	–0.1049	0.0653
	podkarpackie	–0.1217**	0.0611
	podlaskie	–0.0004	0.0679
	pomorskie	–0.1059**	0.0483
	śląskie	0.0979***	0.0370
	świętokrzyskie	0.0143	0.0638
	warm.-mazur.	0.2415***	0.0668
	wielkopolskie	0.0394	0.0381
	zachodniopom.	0.2028***	0.0495
constant		0.9913***	0.1687

Source: Authors' calculation.

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4.2.1. Factors at the POS

The results obtained in the area of transaction and POS characteristics confirm the relevance of the value of payments made: the smaller the value, the higher the probability of paying in cash. The probability of using cash also depends on the type of goods or services purchased and is highest for P2P transactions and lowest for trade.

For obvious reasons, the presence (or rather sighting) of a payment terminal significantly reduces the likelihood of using cash.

4.2.2. Portfolio Features

The *PORTFOLIO FEATURES* include a variable associated with the possession of a payment card that allows performing contactless transactions. This feature significantly discourages the use of cash. This is somewhat in opposition to the results obtained by Brown et al. (2022). Those authors found that contactless cards only slightly dampened the demand for cash. Moreover, they found that more significant changes in payment behavior and cash demand can only be triggered by stronger shocks to the nonpecuniary benefits of cashless payments (relative to cash). One of the possible explanations for this observation might be the fact that the study was performed during the COVID-19 pandemic and contactless payments were seen as a remedy for fear associated with the risk of contracting the disease during cash handling or even manual payment card usage (Wisniewski et al., in press).

The analyses presented here also factor in the time required to get to the nearest ATM. The results show that the farther away the ATM, the more inclined consumer is to use cash. The apparent rationale is that a distant ATM induces more cash to be withdrawn (and consequently to be on hand) and that this cash is more likely to be used at the POS than a payment card. This phenomenon, referred to as "cash burns" in the literature, is consonant with the results obtained by, e.g., Alvarez and Lippi (2017), who showed that cash is used whenever the agent has enough of it, and credit is used when cash holdings are low, a pattern recently documented by household data from several countries.

It should be noted, however, that there are limitations to this observation. At first glance, it could suggest that, *ceteris paribus*, cutting ATM network (and cash access in general) could increase the use of cash. In our view, there is an inflection point of cash access, beyond which the costs of obtaining cash (e.g., in terms of time) would become too great to continue using cash. This, however, does not seem like a policy for reliable withdrawal of cash from circulation (cash-out). Zamora-Pérez (2022), citing available research (Doerr et al., 2022; Mancini-Griffoli et al., 2018), suggests that in certain situations, ensuring that cash is widely available may be more effective than other strategies, e.g., those based on the digital solution. Furthermore, it does not seem possible that a decrease in the ATM network would keep other important factors (like a network of alternative cash access points or POS terminals density) constant.

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4.2.3. Covid Variables

The survey demonstrates that the COVID-19 pandemic, which arrived in Poland in early March 2020, has significantly altered consumer POS behavior. This, in turn, has translated into different propensities to use particular payment instruments. The estimation results confirm the changes in preferences declared in the survey. The declared move away from cash is manifested by a significant decrease in its use. On the other hand, the change toward cash was confirmed by positive parameter estimates (0.1423).

Furthermore, problems with the acceptance of cash at POS during the pandemic resulted in a significant decline in the willingness to use cash by respondents who experienced such a situation. Moreover, the more frequent the problems, the greater the decline was.

COVID VARIABLES appear only in the use model. Therefore, the coefficients in the use equation can be interpreted as the marginal effect of a one unit change in that variable on a dependent variable (see Puhani, 2000). Consequently, according to the estimations parameters of *COVID VARIABLES*, we can observe that the pandemic restrictions affected the cash share decline in the following ways:

– problems with cash acceptance by merchants could reduce the *share of cash payments* by 8.15 percentage points for rare occurrences and by 17.67 percentage points for frequent occurrences of acceptance problems;
– the change of behavior towards cashless could reduce the share of cash by 4.08 percentage points.

4.2.4. Perceptions

The perception of cash in relation to payment cards was also used to assess the use of cash. The results indicate that the perception of cash as being a faster and more secure payment instrument should significantly increase the willingness to use it. Other characteristics (besides the universality of its acceptance) influence this in a similar way, but the results suggest a non-significant role for them.

4.2.5. Demographics

The results for cash use are consistent with those obtained in the adoption model for *card ownership*: an increase in consumer age increases the propensity to use cash, as does a decrease in education level. However, it can be seen that respondents in the lowest age group (15–24), despite having a lower propensity to have a card, have the lowest propensity to use cash at the POS. Differences can also be observed when considering financial expertise. While it has a significant impact on deciding whether to acquire a card, it does not play a significant role when choosing a payment instrument at the POS.

4.2.6. Economy

The decision to use cash at the POS is also determined by income level: the higher it is, the lower the propensity to use cash. Employment status also plays a role in such decisions. The highest propensity to pay in cash primarily characterizes those who stay at home. Retirees rank second. According to the adoption model, they were among the most likely to have a payment card.

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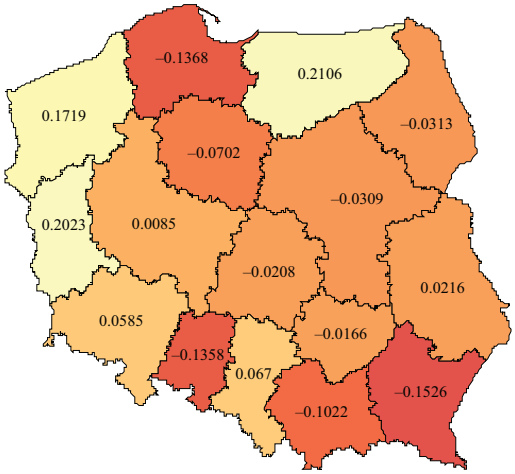
4.2.7. Location

When choosing a payment instrument, the type of region one lives in also matters (although not significantly). It is worth noting the indication of large-medium cities, where the propensity to use cash is the highest. As in the case of the adoption model, there is also a significant geographical variation in the results obtained (see Figure 4). There is a greater propensity to use cash in the western and northern regions.

Figure 4
A map of Poland illustrating the propensity to use cash in the different provinces



Source: Authors' calculation.

4.3. Comparison analysis of the different models

When the analyses presented above were performed on Dataset 3, *minutes to closest ATM*, along with five other variables expressing how various aspects of cash are perceived (*PERCEPTION* class variables), were included. This involved removing those respondents who refused to answer these questions in the survey. The random nature of the data exclusion analysis performed earlier indicated that more respondents with a propensity to use cash for larger payments could be removed, i.e. the distribution of the removed data differed somewhat from that of the data subjected to econometric analysis. This carries the risk of obtaining loaded estimates with an overestimation of the probability of using cash for small payments.

The Heckman approach was used because of removing data of respondents without payment cards. However, there was no reduction due to the data gaps described here. Two models were also estimated to test the possible magnitude of bias. There was no data reduction in the first (Model 1). This is because the variables mentioned above were excluded in the second stage of the Heckman approach. This model was estimated using a sample of 984 respondents (Dataset 1). Model 2 only assumed the inclusion of the *minutes to closest ATM* variable in the second stage of the Heckman approach. This involved reducing the data set to 929 respondents (Dataset 2). A comparison of the results obtained in the variants described above is presented in the Appendix (Tables 10, 11, and 12). These show that there are no significant differences between the estimates of the parameters of the different adoption and use models.

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5. CONCLUSIONS

The present study allows for an understanding of why, and under what circumstances, Polish consumers use cash to pay for goods and services. The obtained results are mostly in line with expectations and results obtained in other countries. They point to several consumer characteristics generally associated with cash payments, such as advanced age, lower income, and lower level of education. We show that perceptions about different payment instruments matter greatly.

Notwithstanding the above, we provide additional observations. The inclusion of variables representing self-reported changes in payment behavior as a result of the COVID-19 pandemic shows that the declared changes are reflected in diary studies. This is especially important, as an eventually unfounded perception that viruses were easily transmitted through banknotes and coins prompted many customers to change their habits and also induced some merchants as far as to refuse to accept cash. Our analyses have shown the relevance of these factors in the choice of payment instruments at the POS – such an experience significantly decreased the probability of using cash during the time of the study.

Furthermore, our study shows that the adoption of contactless payment cards, which is widespread in Poland, significantly increases the likelihood of cash payments being abandoned. In our view, this could be related to two factors: firstly, contactless transactions are generally as fast as cash transactions (and often happen to be quicker) and, secondly, the before-mentioned fear of contracting the disease by cash handling could have inclined customers to use methods of payment that did not require physical contact with any surface.

The analyses also included the spatial aspect. They were not limited to only distinguishing rural and urban types of regions. Specific administrative units of the 16 provinces were also included. The results indicate significant spatial heterogeneity in payment behavior. The spatial aspect was further taken into account by including the time required to reach the nearest ATM. The estimation of the parameters showed that the farther away the ATM, the more inclined the consumer to use cash. This confirms the phenomenon of "cash burns", i.e. cash is used more often when it is on hand, and people possess larger amounts of it when they are distant from withdrawal points.

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APPENDIX

Table 9
Descriptive statistics of variables from Dataset 3

Variables		Obs	Mean	Std.dev.	Median	Min	Max
card ownership		921	0.8415	0.3654	1	0	1
share of cash payment		775	0.3934	0.3437	0.5	0	1
Features of TRX and	TRX value	775	75.3003	61.7640	58.99	6.67	1175.67
POS (base: P2P)	trade	775	0.8560	0.1929	1	0	1
	service	775	0.1169	0.1826	0	0	1
	POS terminal	775	0.8492	0.2174	1	0	1
contactless card adoption		775	0.9548	0.2078	1	0	1
minutes to closest ATM		775	12.1936	6.8149	10	0	60
COVID change behavior (base: no change)	towards cashless	775	0.3587	0.4799	0	0	1
	towards cash	775	0.0632	0.2435	0	0	1
problem with cash payments (base: no)	often	775	0.0219	0.1466	0	0	1
	rarely	775	0.0890	0.2850	0	0	1
perceptions of cash	cash faster	775	–0.0316	0.1042	0	–0.7	.48
	cash easy	775	–0.0088	0.0722	0	–0.4	.22
	cash safe	775	0.0072	0.1030	0	–0.7	.4
	cash cheap	775	0.0250	0.0833	0	–0.48	.4
	cash widespread	775	0.0349	0.0925	0	–0.48	.4
gender	female	921	0.5364	0.4990	1	0	1
age (base: 15–24)	25–39	921	0.2834	0.4509	0	0	1
	40–54	921	0.2845	0.4514	0	0	1
	55–64	921	0.1368	0.3438	0	0	1
	65+	921	0.2237	0.4169	0	0	1
education (base: high)	primary	921	0.0652	0.2469	0	0	1
	basic_voc/prof	921	0.3051	0.4607	0	0	1
	secondary	921	0.4680	0.4992	0	0	1
financial knowledge (base: high)	low	921	0.3952	0.4892	0	0	1
	average	921	0.3388	0.4735	0	0	1

DOI: 10.7172/2353-6845.jbfe.2023.1.5

continued Table 9

Variables		Obs	Mean	Std.dev.	Median	Min	Max
income (base: >3800)	<1300	921	0.0521	0.2224	0	0	1
	1301–1800	921	0.0988	0.2986	0	0	1
	1801–2400	921	0.2106	0.4080	0	0	1
	2401–3800	921	0.2638	0.4410	0	0	1
	refuse/don't know	921	0.2367	0.4253	0	0	1
economic activity (base: self-employed)	employed	921	0.6699	0.4705	1	0	1
	student	921	0.0369	0.1887	0	0	1
	stay at home	921	0.0098	0.0984	0	0	1
	unemployed	921	0.0033	0.0570	0	0	1
	retired	921	0.2714	0.4449	0	0	1
type of region (base: large cities)	rural	921	0.2519	0.4343	0	0	1
	suburban village	921	0.1140	0.3180	0	0	1
	small towns	921	0.1292	0.3356	0	0	1
	medium cities	921	0.2139	0.4103	0	0	1
voivodships (base: mazowieckie)	dolnośląskie	921	0.0413	0.1990	0	0	1
	kuj.-pomorskie	921	0.0619	0.2411	0	0	1
	lubelskie	921	0.0554	0.2288	0	0	1
	lubuskie	921	0.0358	0.1860	0	0	1
	łódzkie	921	0.0565	0.2309	0	0	1
	małopolskie	921	0.0836	0.2769	0	0	1
	opolskie	921	0.0261	0.1594	0	0	1
	podkarpackie	921	0.0521	0.2224	0	0	1
	podlaskie	921	0.0369	0.1887	0	0	1
	pomorskie	921	0.0554	0.2288	0	0	1
	śląskie	921	0.1346	0.3415	0	0	1
	świętokrzyskie	921	0.0380	0.1913	0	0	1
	warm.-mazur.	921	0.0315	0.1747	0	0	1
	wielkopolskie	921	0.0955	0.2941	0	0	1
	zachodniopom.	921	0.0434	0.2039	0	0	1

Source: Authors' calculation.

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Table 10
Comparison of models

	Model 1	Model 2	Model 3
No of obs	984	929	921
Selected	838	783	775
Non-selected	146	146	146
Lambda	0.0883	0.1111**	0.0838
Rho	0.3448	0.4409	0.3380
Sigma	0.2560	0.2521	0.2478

Note: The models differ in the set of variables at the second stage concerning the use of the model: Model 1 does not contain variables determining the time to reach the nearest ATM and variables expressing the perception of cash; Model 2 does not contain variables expressing the perception of cash; Model 3, described in the main part of the article, contains all, previously highlighted variables.

Source: Authors' calculation.

Table 11
Adoption models for Datasets 1, 2, and 3. Dependent variable: *card ownership*

		Model 1	Model 2	Model 3
female		0.2256	0.2182	0.2060
age (base: 15–24)	25–39	0.1372	0.0780	0.1644
	40–54	0.1841	0.1914	0.2722
	55–64	–1.2454***	–1.2956***	–1.2101***
	65+	–1.6036***	–1.5991***	–1.5185***
education (base: high)	primary	–2.8141***	–2.8540***	–2.8234***
	basic voc/prof	–1.5626***	–1.5453***	–1.5427***
	secondary	–0.7564	–0.7091	–0.6775
financial knowledge (base: high)	low	–0.7756***	–0.8254***	–0.8338***
	average	–0.4815	–0.5211*	–0.5165*
income (base: >3800)	<1300	–0.6837	–0.6545	–0.6387
	1301–1800	–0.2160	–0.2695	–0.2859
	1801–2400	–0.2084	–0.2292	–0.2201
	2401–3800	–0.0809	–0.0991	–0.0857
	refuse	–0.5923	–0.6269	–0.6320

DOI: 10.7172/2353-6845.jbfe.2023.1.5

continued Table 11

		Model 1	Model 2	Model 3
economic activity (base: self-employed)	employed	1.1648	1.0878	1.0612
	student	1.0493	0.7908	0.6833
	stay at home	0.1392	0.0453	0.0320
	unemployed	5.7323	5.6588	5.6104
	retired	1.2524	1.1998	1.1823
type of region (base: large cities)	rural	–0.1668	–0.1716	–0.2107
	suburban village	0.4701*	0.4216	0.4161
	small towns	0.2788	0.2551	0.2414
	medium cities	0.4446*	0.4477*	0.4374*
voivodships (base: mazowieckie)	dolnośląskie	5.6866	5.7207	5.7346
	kuj.-pomorskie	–1.0152***	–0.9826***	–0.9767***
	lubelskie	0.6812	0.6160	0.6314
	lubuskie	6.4363	6.5186	6.4705
	łódzkie	0.4067	0.4007	0.2713
	małopolskie	–0.7636**	–0.7352**	–0.7307**
	opolskie	–0.8614*	–0.8265	–0.8221
	podkarpackie	–1.0427***	–1.2747***	–1.2708***
	podlaskie	–1.2715***	–1.2090***	–1.1859***
	pomorskie	–0.6812*	–0.6628*	–0.7061*
	śląskie	–0.5628*	–0.5695*	–0.5761*
	świętokrzyskie	–1.7024***	–1.6731***	–1.6565***
	warm.-mazur.	–1.0013**	–1.0436**	–1.0425**
	wielkopolskie	1.1914**	1.2018**	1.2051**
	zachodniopom.	0.9853*	0.7862	0.7859
constant		3.0809***	3.2109***	3.1669***

Source: Authors' calculation.

DOI: 10.7172/2353-6845.jbfe.2023.1.5

Table 12
Use models for Datasets 1, 2, and 3. Dependent variable: *share of cash payment*

		Model 1	Model 2	Model 3
TRX value		–0.0009***	–0.0009***	–0.0008***
TRX place type (base: P2P)	trade	–0.2546**	–0.2291*	–0.2198**
	service	–0.1451	–0.1405	–0.1399
POS terminal		–0.5783***	–0.5799***	–0.5692***
contactless card adoption		–0.1414***	–0.1438***	–0.1434***
minutes to closest ATM			0.0031**	0.0030**
COVID change behavior (base no: change)	toward cashless	–0.0495**	–0.0486**	–0.0408*
	toward cash	0.1378***	0.1440***	0.1423***
problem with cash payments (base: no)	often	–0.1510**	–0.1582**	–0.1767***
	rarely	–0.0952***	–0.0848**	–0.0815**
perceptions of cash	cash faster			0.2355**
	cash easy			0.0838
	cash safe			0.1723*
	cash cheap			0.1516
	cash widespread			–0.1255
female		0.0200	0.2189	0.0181
age (base: 15–24)	25–39	0.0413	0.0362	0.0387
	40–54	0.0999**	0.1008***	0.0912**
	55–64	0.1087**	0.0713	0.0644
	65+	0.1993***	0.1587***	0.1501***
education (base: high)	primary	0.1175*	0.1485*	0.1465*
	basic_voc/prof	0.0570*	0.0690**	0.0584*
	secondary	0.0363	0.0347	0.0379
financial knowledge (base: high)	low	0.0443*	0.0313	0.0119
	average	0.0073	–0.0008	-0.0069
income (base: >3800)	<1300	0.1996***	0.1834***	0.1762***
	1301–1800	0.0919**	0.0729*	0.0554
	1801–2400	0.0641*	0.0574*	0.0553
	2401–3800	0.0121	–0.0034	–0.0075
	refuse/don't know	0.0561*	0.0410	0.0405

DOI: 10.7172/2353-6845.jbfe.2023.1.5

continued Table 12

		Model 1	Model 2	Model 3
economic activity (base: self-employed)	employed	0.0866	0.0844	0.0830
	student	0.0900	0.0732	0.0615
	stay at home	0.2839*	0.2895*	0.3143**
	unemployed	–0.0413	–0.0402	–0.0277
	retired	0.1029	0.0985	0.1028
type of residence (base: large cities)	rural	0.0158	–0.0167	–0.0198
	suburban village	–0.0364	–0.0538	–0.0418
	small_towns	–0.0091	–0.0235	–0.0194
	medium cities	0.0372	0.0208	0.0263
voivodships (base: mazowieckie)	dolnośląskie	0.0667	0.0633	0.0894*
	kuj.-pomorskie	–0.0395	–0.0535	–0.0393
	lubelskie	–0.0190	–0.0086	0.0093
	lubuskie	0.2723***	0.2484***	0.2332***
	łódzkie	0.0148	–0.0015	0.0101
	małopolskie	–0.0746*	–0.0853**	–0.0713*
	opolskie	–0.0898	–0.0957	–0.1049
	podkarpackie	–0.0736	–0.1564***	–0.1217**
	podlaskie	–0.0219	–0.0273	–0.0004
	pomorskie	–0.1000**	–0.1207**	–0.1059**
	śląskie	0.0996***	0.0815**	0.0979***
	świętokrzyskie	–0.0101	–0.0231	0.0143
	warm.-mazur.	0.2242***	0.2226***	0.2415***
	wielkopolskie	0.0490	0.0394	0.0394
	zachodniopom.	0.2101***	0.1987***	0.2028***
constant		1.0020***	0.9953***	0.9913***

Source: Authors' calculation.

DOI: 10.7172/2353-6845.jbfe.2023.1.5

Załącznik A.

Oświadczenia współautorów artykułów

Oświadczenia do artykułu pt. "Switching from cash to cashless payments during the COVID-19 pandemic and beyond"

Riyadh, 26/05/2023

STATEMENT OF AUTHORSHIP

We, the co-authors of the article titled "Switching From Cash to Cashless Payments During the COVID-19 Pandemic and Beyond", accepted for publication in the *International Journal of Central Banking*, declare that the substantive participation of individual co-authors in the preparation of this article was shaped as described in the table below.

	Wisniewski T.P.	**Polasik M.**	**Kotkowski R.**	**Moro A.**
Affiliation in the article	Alfaisal University	Nicolaus Copernicus University in Toruń	Nicolaus Copernicus University in Toruń	Cranfield University
Conceptualization	x	x	x	x
Data curation			x	x
Formal analysis	x	x	x	
Funding acquisition		x		
Investigation			x	
Methodology	x	x	x	x
Project administration	x	x		
Resources				x
Software			x	x
Supervision	x	x		
Validation	x	x		
Visualization				x
Writing – original draft	x		x	
Writing – review & editing	x	x	x	
Estimated contribution to publication [in %]	30%	20%	30%	20%

In addition, we declare that the list of co-authors of the article does not include the names of persons whose participation in its creation was negligible or did not take place at all ("guest authorship" is excluded). And all persons who had a role in the creation of this article have been included either as co-authors or as persons whom the authors thank for their help in the development of the article, and that authorship/co-authorship is not attributed to a person who made no significant contribution to the development of the article ("ghost writing" is excluded).

Tomasz Wisniewski

T.P. Wisniewski

Torun, 26/05/2023

STATEMENT OF AUTHORSHIP

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Conceptualization	x	x	x	x
Data curation			x	x
Formal analysis	x	x	x	
Funding acquisition		x		
Investigation			x	
Methodology	x	x	x	x
Project administration	x	x		
Resources				x
Software			x	x
Supervision	x	x		
Validation	x	x		
Visualization				x
Writing – original draft	x		x	
Writing – review & editing	x	x	x	
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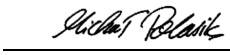

M. Polasik

Warsaw, 26/05/2023

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Conceptualization	x	x	x	x
Data curation			x	x
Formal analysis	x	x	x	
Funding acquisition		x		
Investigation			x	
Methodology	x	x	x	x
Project administration	x	x		
Resources				x
Software			x	x
Supervision	x	x		
Validation	x	x		
Visualization				x
Writing – original draft	x		x	
Writing – review & editing	x	x	x	
Estimated contribution to publication [in %]	30%	20%	30%	20%

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R. Kotkowski

Cranfield, 26/05/2023

STATEMENT OF AUTHORSHIP

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	Wisniewski T.P.	**Polasik M.**	**Kotkowski R.**	**Moro A.**
Affiliation in the article	Alfaisal University	Nicolaus Copernicus University in Toruń	Nicolaus Copernicus University in Toruń	Cranfield University
Conceptualization	x	x	x	x
Data curation			x	x
Formal analysis	x	x	x	
Funding acquisition		x		
Investigation			x	
Methodology	x	x	x	x
Project administration	x	x		
Resources				x
Software			x	x
Supervision	x	x		
Validation	x	x		
Visualization				x
Writing – original draft	x		x	
Writing – review & editing	x	x	x	
Estimated contribution to publication [in %]	30%	20%	30%	20%

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Andrea Moro

A. Moro

Oświadczenia do artykułu pt. "COVID-19 pandemic increases the divide between cash and cashless payment users in Europe"

Warszawa, dnia 26 maja 2022 r.

OŚWIADCZENIE O AUTORSTWIE

My, współautorzy artykułu pt. „COVID-19 Pandemic Increases the Divide Between Cash and Cashless Payment Users in Europe" opublikowanego w czasopiśmie *Economics Letters* oświadczamy, że udział merytoryczny poszczególnych współautorów w przygotowaniu tego artykułu kształtował się w sposób opisany w tabeli poniżej.

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Pozyskiwanie finansowania *[Funding acquisition]*		x
Badanie *[Investigation]*	x	x
Metodyka *[Methodology]*	x	
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Kuratorstwo danych *[Data curation]*	x	
Analiza formalna *[Formal analysis]*	x	
Pozyskiwanie finansowania *[Funding acquisition]*		x
Badanie *[Investigation]*	x	x
Metodyka *[Methodology]*	x	
Administracja projektem *[Project administration]*		x
Zasoby *[Resources]*	x	
Oprogramowanie *[Software]*	x	
Nadzór *[Supervision]*		x
Walidacja *[Validation]*		x
Wizualizacja *[Visualization]*	x	
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M. Polasik

Oświadczenie do artykułu pt. "Pandemia COVID-19 a popyt na pieniądz gotówkowy i zmiany w zachowaniach płatniczych w Polsce w 2020 r."

Warszawa, dnia 28 czerwca 2022 r.

OŚWIADCZENIE O AUTORSTWIE

My, współautorzy artykułu pt. „Pandemia COVID-19 a popyt na pieniądz gotówkowy i zmiany w zachowaniach płatniczych w Polsce w 2020 r." opublikowanego w czasopiśmie *Studia i Prace Kolegium Zarządzania i Finansów* oświadczamy, że udział merytoryczny poszczególnych współautorów w przygotowaniu tego artykułu kształtował się w sposób opisany w tabeli poniżej.

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Konceptualizacja *[Conceptualization]*	x	x	x
Kuratorstwo danych *[Data curation]*		x	
Analiza formalna *[Formal analysis]*		x	x
Pozyskiwanie finansowania *[Funding acquisition]*	ND		
Badanie *[Investigation]*		x	x
Metodyka *[Methodology]*	x		x
Administracja projektem *[Project administration]*	x		
Zasoby *[Resources]*			x
Oprogramowanie *[Software]*		x	
Nadzór *[Supervision]*	x		
Walidacja *[Validation]*			x
Wizualizacja *[Visualization]*		x	
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Oświadczenia do artykułu pt. "Cash usage in Poland in 2020: Insights into the role of the COVID-19 pandemic and spatial aspects"

Warszawa, dnia 11 lipca 2023 r.

OŚWIADCZENIE O AUTORSTWIE

My, współautorzy artykułu pt. „Cash Usage in Poland in 2020: Insights Into the Role of COVID-19 Pandemic and Spatial Aspects" opublikowanego w czasopiśmie *Journal of Banking and Financial Economics* oświadczamy, że udział merytoryczny poszczególnych współautorów w przygotowaniu tego artykułu kształtował się w sposób opisany w tabeli poniżej.

	Kotkowski R.	**Manikowski A.**
Afiliacja w artykule	Uniwersytet Mikołaja Kopernika w Toruniu	Uniwersytet Warszawski, Narodowy Bank Polski
Konceptualizacja *[Conceptualization]*	x	x
Kuratorstwo danych *[Data curation]*	x	
Analiza formalna *[Formal analysis]*		x
Pozyskiwanie finansowania *[Funding acquisition]*	x	
Badanie *[Investigation]*	x	x
Metodyka *[Methodology]*	x	x
Administracja projektem *[Project administration]*	x	
Zasoby *[Resources]*		x
Oprogramowanie *[Software]*		x
Nadzór *[Supervision]*		x
Walidacja *[Validation]*	x	
Wizualizacja *[Visualization]*	x	x
Pisanie – oryginalny szkic *[Writing – original draft]*		x
Pisanie – recenzja i edycja *[Writing – review & editing]*	x	
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Andrzej Kotkowski

R. Kotkowski

Warszawa, dnia 11 lipca 2023 r.

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Analiza formalna *[Formal analysis]*		x
Pozyskiwanie finansowania *[Funding acquisition]*	x	
Badanie *[Investigation]*	x	x
Metodyka *[Methodology]*	x	x
Administracja projektem *[Project administration]*	x	
Zasoby *[Resources]*		x
Oprogramowanie *[Software]*		x
Nadzór *[Supervision]*		x
Walidacja *[Validation]*	x	
Wizualizacja *[Visualization]*	x	x
Pisanie – oryginalny szkic *[Writing – original draft]*		x
Pisanie – recenzja i edycja *[Writing – review & editing]*	x	
Szacunkowy wkład w publikację [w %]	50%	50%

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Arkadiusz Manikowski

A. Manikowski

Summary

The impact of the COVID-19 pandemic on cash demand and changes in payment behavior: A collection of empirical studies

The COVID-19 pandemic outbreak led to drastic changes in many areas of social and economic life worldwide. This doctoral dissertation's research aims to enhance our understanding of how the pandemic affected the demand for cash and consumers' payment behaviors. The COVID-19 pandemic observed a significant increase in cash demand and a decrease in its use for transactional purposes, thereby deepening an already established phenomenon known as the "cash paradox."

The study findings suggest that concerns about contracting the SARS-CoV-2 virus through handling cash and alterations in their daily routines primarily influenced customers' payment behaviors. Prior to the pandemic, individuals who favored non-cash transactions were more inclined to persist in this behavior and potentially even increase the frequency of using such methods. Conversely, individuals who had a higher frequency of cash usage in the past showed a lower inclination to transition to cashless payment methods. This situation leads to an increasing social divide in the use of payment instruments. National considerations substantially influence the ability of inhabitants in different countries to adapt to external influences, such as a pandemic.

In Poland, the surge in money demand during the COVID-19 pandemic was not driven by transactional motives but rather by hoarding. This is demonstrated by the fact that Poland had a two-fold decrease in the use of physical money for transactions, surpassing the rate of decline observed in the period before the epidemic in 2020. Simultaneously, Poland experienced the biggest surge in cash demand compared to other European countries. International research has demonstrated that a characteristic of national culture known as uncertainty avoidance played a substantial role in driving the heightened need for cash during the initial year of the COVID-19 epidemic. This implies that during pe-

riods of uncertainty, customers have a tendency to amass cash as a secure asset, even if they have no intention of using it for transactions.

Another notable finding was the impact of merchants' rejection of cash, which greatly diminished its usage among consumers in subsequent transactions. In Poland, the response to this challenge was the implementation of legal regulations initiated by the Narodowy Bank Polski (Polish central bank), which mandated merchants to accept cash payments. This measure was intended to guarantee the continued social acceptance of cash as a form of payment and to prevent financial exclusion.

The findings in the studies not only documented significant social and economic occurrences but also provided guidance for future research and practical interventions on both an international and domestic scale. Several potential studies include: (i) investigating the long-term effects of the COVID-19 pandemic on payment behavior once the epidemic subsides; (ii) assessing the safety of various payment methods in terms of disease transmission; (iii) examining how national factors, such as the prevalence of cash in the informal economy, varying levels of payment method adoption, or the scale of payment infrastructure, influence changes in payment behavior across different countries; and (iv) exploring the impact of national culture on the demand for cash during periods of heightened uncertainty and on the rate of payment behavior change.

Practical measures that can be implemented include: (a) central banks increasing their cash reserves and enhancing the efficiency of cash supply chains to meet growing demand and prevent bank panic; (b) raising public awareness about the health risks associated with handling cash; and (c) governments and public institutions in each country considering legislative actions to ensure the continuity of cash access and acceptance.