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The role of risk in e-retailers' adoption of payment methods: evidence for transition economies

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Abstract We use logit analysis to exploit a self-collected dataset on the payment and delivery options offered by the vast majority of B2C websites in five Central Asian transition economies. Specifically, we conduct a supply-side test of (elements of) the Transaction Context Model, which highlights the role of perceived risk. Our results confirm that e-retailers in sectors with higher average transaction values are more likely to adopt 'pay in advance' instruments—such as debit cards—that have a lower payment risk for the seller. We also find that merchants who offer higher-risk delivery options are more prone to also adopt higher-risk payment instruments (such as credit cards). Our control variables also yield interesting results. In particular, in line with the network externalities theory, we find evidence that the offline penetration of a payment instrument positively affects online merchant adoption.

Keywords Online payment methods · Transaction context · Risk · Delivery methods · B2C e-commerce · Transition economies

1 Introduction

E-commerce depends greatly on the availability of secure payment channels and a reliable delivery infrastructure [12, 31, 52]. Both are important drivers of e-commerce adoption. On the supply side, any e-commerce business must, by

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definition, provide at least one type of payment and delivery mechanism [15]. On the demand side, the availability of convenient payment and delivery options may affect consumers' decision to purchase from a website or not [1].

The majority of prior studies have focused on the impact of payment (and delivery) options on *consumer* uptake of e-commerce [30, 37]; the supply side has largely been ignored. In this paper we therefore focus on the latter. In terms of geographical focus, we have been guided by two related observations. First, poor online payment facilities and erratic logistics are the most widely cited problems of engaging in business-to-consumer (B2C) e-commerce in developing countries in general [40, 47]. Second, while several scholars have acknowledged the importance of research on Information and Communication Technologies (ICT) specifically focused on transition economies[1]—see, for example, Roztocki and Weistroffer [54]—empirical evidence on the diffusion of e-commerce in these countries is in short supply.

In view of these considerations, we decided to examine the adoption of payment methods by B2C e-retailers in Central Asia, and more specifically in Kazakhstan (Kz), Kyrgyzstan (Kg), Tajikistan (Tj), Turkmenistan (Tm), and Uzbekistan (Uz), as these are the biggest markets in the region—albeit, and this is interesting in itself, at different levels of economic advancement. Since little or no prior information was available, we decided to collect primary data ourselves. This has resulted in a unique database comprising information on 194 B2C e-commerce websites, which should come close to covering the entire population in the five countries that we study (at least at the time of collection of the data). As we will document, our Central Asian e-retailers accept a markedly different mix of payment instruments compared to their counterparts in developed countries. In our dataset, adoption also varies dramatically, not only between but also within countries. This makes our sample ideally suited for our purposes; testing our main hypotheses would in fact seem just about impossible for countries where, say, the vast majority of websites accept credit cards.

In what follows, we use logit analysis to explain the adoption of selected payment methods by Central Asian e-retailers—for example, whether they accept credit cards or not—by means of site-, sector- and country-level variables. The focus of our analysis is on the role of payment and delivery risk, in a partial test of the theoretical framework proffered by Liezenberg et al. [34]. Our results confirm that higher product value, which we measure at the sector level, increases the probability that online merchants adopt 'pay in advance' instruments—such as debit cards—that have a lower payment risk for the seller. Also in line with Liezenberg et al.'s Transaction Context Model (TCM), we find a negative relationship between product value and the adoption of credit cards, which are in effect 'pay afterwards' and therefore higher-risk for the seller. However, here we cannot exclude a competing explanation (in the form of higher transaction fees). Interestingly, we also find that merchants' attitudes vis-à-vis payment and delivery risk are interlinked, in that merchants who offer higher-risk delivery options are also more prone to adopt higher-risk payment instruments, which

[1] Transition economies can be defined as "economies that are in transition from a communist style central planning system to a free market system" [53].

again indicates that risk plays a role in their choice of payment instruments. To be clear: we do not attempt to explain the adoption of delivery methods as such. We only discuss delivery methods so as to be able to analyze their symbiotic relationship with the payment methods offered by a site.

The remainder of the paper is structured as follows. In the next section, we try to paint a picture of the state of affairs in Central Asia when it comes to delivery and especially payment methods for e-commerce. In Sect. 3 we discuss the prior literature and introduce the theoretical framework that we will rely on. Section 4 then zooms on the differences in finality and risk between payment instruments, as these are key for the development of our hypotheses, which are presented in Sect. 5. The empirical part of the paper starts in Sect. 6, where we explain the data collection, define the variables, provide descriptive statistics, and set out our methodology. Finally, Sect. 7 presents our results and Sect. 8 concludes.

2 The context

In the traditional socialist system, households could only use cash, and all money transfers among enterprises were handled by the central bank [11]. In today's Central Asia, the range of payment instruments is obviously larger. However, in most countries cash continues to dominate, and payment cards are not yet common. Also, despite the fact that two decades have passed since the collapse of the Soviet Union, in many transition countries the financial sector is still not mature enough to handle, for example, online bank transfers [21].

In Table 1, we have attempted to document, for the five countries that we investigate, the state of the non-cash payments market—and in particular the market for payment cards—at the time of our data collection (in 2010); see Sect. 6.1. We are not aware of comprehensive data on the more novel instruments that have been developed specifically for the online world, such as electronic money. In fact, in spite of our use of a wide range of sources, even for payment cards the picture is patchy and not always fully consistent. Still, Table 1 does highlight a number of interesting inter-country differences.

A first observation relates to the wide divergences in the relative importance of the 'unbanked'; that is, adults who have no access to formal financial services. According to World Bank [8] data relating to 2011, 42 % of the adult population in Kazakhstan would have an account at a formal financial institution, whereas this figure is just about 0 % in Turkmenistan. EBRD survey data [9] that look at the share of households (rather than individuals) that have a *bank* account are predictably lower, but the discrepancies remain. Note that the correlation between the two indicators is high (0.92), but not perfect. Especially the 1.7 % for Uzbekistan in the EBRD data catches the eye.

When it comes to payment cards, we have used two types of sources. For one, we have used (mainly) central bank publications to compile hard data on the number of cards issued and on the volume and value of transactions. However, these data only make a distinction, if at all, between international and local card brands, not between debit and credit cards. Crucially, 'international brands' need not equate

Table 1 State of the payment cards market, in 2010–2011: inter-country comparison

	Kazakhstan	Kyrgyzstan	Tajikistan	Turkmenistan	Uzbekistan
General information					
Population (in 2009)[c]	15,888,000	5,321,000	6,952,000	5,110,000	27,767,000
GDP per capita, in US $ (in 2009)[c]	6 870	860	716	3 904	1 182
Financial inclusion					
Bank account (% households, in 2010)[f]	10.4	0.5	0.7	n.a.	1.7
Account at a formal financial institution (% age 15 + , in 2011)[g]	42	4	3	0	23
Penetration of payment cards					
Number of cards issued (mid-2010)	8,048,700	184,929	69,050	n.a.	7,000,000
Local brands	167,900	109,393	–	–	–
International brands	7,880,700	75,536	–	–	100,000[b]
Visa	6,504,900	74,591	–	–	–
MasterCard	–	945	–	–	–
Europay	1,367,300	–	–	–	–
Number of cards issued per 1000 people	507	35	10	n.a.	252
Usage of payment cards					
Volume of transactions (estimate for 2010, except Uz: 2007)	139,200,000	3,331,608	1,306,800	–	(14,500,000)[c]
Value of transactions, in US $ (estimate for 2010)[a]	22,136,278,668	257,005,900	142,879,968	–	3,325,123,152[d]
Average value of transaction, in US $ (estimate for 2010, except Uz)	159	78	109	–	(229)
Survey data on card adoption					
Credit card (% households, in 2010)—EBRD[f]	5.9	0.7	1	n.a.	0.8
Credit card (% age 15 + , in 2011)—World Bank[g]	9	1	1	0	3
Debit card (% households, in 2010)—EBRD[f]	7.3	0.2	0.1	n.a.	4.3

Table 1 continued

	Kazakhstan	Kyrgyzstan	Tajikistan	Turkmenistan	Uzbekistan
Debit card (% age 15 + , in 2011)—World Bank[g]	31	2	2	0	20

Numbers do not always add up due to rounding. Also, because data sometimes relate to different years, some of the indicators should be seen as estimates, and comparability across countries can be imperfect. For example, most usage figures for Uz relate to 2007 (which is why they appear between brackets). Note also that, with the exception of Uz, the figures on the number of transactions were extrapolated based on monthly, quarterly or half-yearly figures

[a] Values converted into USD at the official exchange rate (as of August 25, 2010): USD 1 = KZT 147.12; USD 1 = KGS 46.52; USD 1 = TJS 4.38; USD 1 = TMM 2.85; USD 1 = UZS 1624

Source Authors' own compilation based on National Bank of the Republic of Kazakhstan [46]; National Bank of the Kyrgyz Republic [45]; National Bank of Tajikistan [44]; National Bank for Foreign Economic Activity of the Republic of Uzbekistan [43]; [b] Plus Journal [50]; [c] Avesta Investment Group [4], MoneyNews [41]; [d] Trend Capital [58]; [e] World Bank [63]; [f] EBRD [9]; [g] Demirgüç-Kunt and Klapper [8]

with credit cards; Visa Electron and Maestro, for example, are debit card brands. We have therefore complemented the hard data with survey data from the World Bank [8] and the EBRD [9].

Starting with the hard data, it can be seen that, compared to its neighboring states, the adoption of cards from international schemes is well advanced in Kazakhstan (with a penetration rate of roughly 50 % in 2010). A limited number of such cards also circulate in Kyrgyzstan and Uzbekistan. Tajikistan and Turkmenistan are missing observations. Interestingly, in Uzbekistan local cards dominate the market. Indeed, the bulk of the 7 million cards mentioned in Table 1 are local debit cards (of a specific type). Of the roughly 6 million cards that the Bank of Uzbekistan, for example, had issued by the end of 2008, 98 % were local cards [50]. Importantly, when we collected our data, the majority of the debit cards issued by Uzbek banks could only be used to pay at Point-of-Sale (POS) terminals (either fixed or mobile), and could not be used online. We will refer to these cards as "payroll cards" as they are often marketed to employers as a cost-effective means of providing wages to employees who lack a traditional banking relationship [10]. Continuing our overview, both Kyrgyzstan and Tajikistan are clearly lagging behind, with (overall) penetration rates of merely 3.5 and 1 %, respectively. Turkmenistan is again a blank spot.

Confronting these numbers with the survey data on card adoption reveals that the bulk of the international cards issued in Kazakhstan are in fact not credit but debit cards. According to the World Bank data, 31 % of the Kazakhs would have a debit card and 9 % a credit card. Taking into account that certain individuals may well have multiple cards, these figures tally relatively well with the 50 % penetration rate of international cards mentioned above. The EBRD data are lower because they are measured on the level of households, but they are consistent with the World Bank data. For credit cards the correlation between the EBRD and World Bank data is 0.96; for debit cards it is even 0.99.

Even though Table 1 paints only a partial picture of the payments market in our 5 'Stan countries', it does demonstrate that local e-commerce ventures face additional challenges compared to their counterparts in the developed world. Indeed, local

Table 2 Delivery methods: definitions

Method	Definition
Postal system	The country's national postal system, which may include products such as Express Mail Service (EMS)
Courier service	An independent delivery service provider similar to DHL or FedEx. Relatively expensive compared to the national postal system. Offers both express and slower surface delivery methods
Private service	Private delivery service operated by the e-retailer and usually limited to a specific region
In-store pick-up	Customers visit the e-retailer's physical store or distribution outlet to collect items ordered online. Payment can in principle be done either online or at the time of collection
Electronic	Delivery of digital goods such as music, video, books or customizable gift-cards

Source Authors' own compilation based on prior literature (e.g., Hawk [15]; Lee and Whang [32])

e-retailers are handicapped by the low card penetration and by the absence of an online banking system. The environment is no less challenging when it comes to logistics. In the traditional socialist system, large state-owned enterprises dominated most industries, including transportation and logistics. Today, transportation facilities in many transition economies are still poorly developed. The national postal system is a relatively cheap method of distribution, but in most post-soviet states it is characterized by poor quality of service. It is functional but cannot be considered secure or reliable enough to provide efficient logistics for e-commerce [14]. It is definitely not suited for urgent deliveries because of the scarcity of regional flights [38]. In addition, there is the bureaucratic legal environment. In line with these remarks, our survey reveals that a substantial portion of the sites have set up delivery options that they can fully control: across all countries, 31 % offer in-store pick-up and 19 % have a privately delivery service; see Table 2 for definitions. In Uzbekistan, these percentages are even 36 and 39 %, respectively. Tellingly, the national postal system is only used in Kazakhstan (by 23 % of the local sites).

In short, compared to their counterparts in the develop world online merchants in the five countries that we study have to operate in a decidedly more risky environment, for sellers and buyers alike. In the present paper, we therefore wanted to explore how local e-retailers respond to these challenges, and in particular how the higher risk affects their choice of payment instruments. We thus needed a theoretical framework that explicitly incorporates this (potential) determinant.

3 Prior literature and theoretical framework

The payments literature does not lack papers about the incidence of card fraud; see Ardizzi [3] and King [27] for recent examples. Moreover, it is intuitively clear that fraud and, broader, 'payment risk'[2] effectively matter for merchants, both off- and

[2] As described in Arango and Taylor [2, p. 6], payment risk can be seen as comprising the risk of fraud/counterfeiting, the risk of theft (internal or external), the risk of human error during the exchange,

online. Anecdotal evidence confirms this. For example, where real-world merchants are concerned, in a 2006 national survey commissioned by the Bank of Canada, risk was mentioned as a main barrier by 73 % of those not accepting checks [2, p. 9]. Mallat and Tuunainen [36], for their part, examine Finnish merchants' intention to adopt mobile payment systems. In the qualitative part of their research they interview representatives from 15 companies from diverse sectors. Mallat and Tuunainen report that "the interviewees described trust in payment service providers and the security of payment solutions as important prerequisites for the adoption of mobile payments" (o.c., p. 46). One interviewee, from the ticketing sector, is quoted as saying: "I require that when we sell a service, we get information that the payment transaction has been successful, that there is money and [that] it will be sent to us". Finally, where e-retailers are concerned, in the Netherlands the Social Platform on Payment Systems [28] in late 2009 conducted a (non-representative) pilot survey among 27 merchants about their (non-)acceptance of credit cards. Eight of these merchants were web merchants—5 of which accepted credit cards. In response to an open question about possible reasons why they would stop accepting credit cards, arguments related to payment risk were proffered three times: "increase in risks and administrative burden of chargebacks" (2) and "increase in fraud" (1) (o.c., p. 9).[3]

Risk would thus appear to be a factor that should be taken into account when studying merchant acceptance of payment instruments. Surprisingly, however, it is absent in most research into the matter. We are, for example, aware of three papers that follow an innovation-theoretic approach. In innovation theory, 'relative advantage'—that is, the degree to which an innovation is perceived to be superior to current offerings—is an important antecedent of adoption. Applied to payment instruments, one dimension of the relative advantage construct could well relate to trust and security. However, neither Plouffe et al. [49] nor Truman et al. [59], who both study in—market trials of stored-value cards in, respectively, Canada and the US, have such a measure. Only Mallat and Tuunainen [36], in their study on early mobile payment solutions in Finland, have questions on perceived trust and security, such as "Mobile payments are secure" and "Mobile payments have a small risk of misdemeanor". Mallat and Tuunainen find that these measures effectively discriminate between merchants with and without intention to adopt. Unfortunately, in our setting using a similar approach was not really an option, as it requires merchants to fill out a detailed questionnaire. For another paper we had already experimented with a survey among our target audience, and based on this experience we anticipated that response levels would simply be too low.

Footnote 2 continued
as well as finality risk, "the risk that a provisional transfer of funds or securities will be rescinded" (CPSS [7, p. 24]).

[3] As Arango and Taylor [2, p. 6] explain, "consumers have a certain number of days to dispute a credit card transaction, whether it is because of an unresolved dispute with the merchant or because there is a fraudulent claim (i.e., the card was used without the cardholder's consent). In these cases, the transaction will be reversed through a chargeback". Note that in the Dutch survey multiple answers were possible, so the 3 need not equate with 3 out of the 5 credit card accepting merchants.

In our search for other possible theoretical frameworks, we found only two models that explicitly incorporate risk as a determinant of merchant acceptance of payment instruments.[4] In a 2007 article in a payments journal, Liezenberg et al. [34] develop the so-called 'TCM', which highlights the factors that influence the risk perceived in a transaction. Li et al. [33] also model payment method choice as a function of, among other factors, the risk involved for the parties to the transaction. Compared to the Li et al. model, the Liezenberg et al. model is less formal but more realistic. Indeed, Li et al. seem to suggest that, irrespective of the payment instrument used, buyer and seller *both* face a fraud risk—which need not be the case, as will be demonstrated in Sect. 4.[5] We therefore decided to rely on Liezenberg et al.'s TCM, which is as yet untested, as the basic theoretical framework of our paper.

The starting point of the TCM is the observation that a transaction typically consists of two actors (buyer and seller) and three core processes: agreement (A), payment (P), and delivery (D) (o.c., p. 219). Each of these processes contains a (perceived) level of risk that is distributed between buyer and seller: R_A is the risk that an agreement is not clear or cancelled, R_P is the risk that the payment is not executed or not guaranteed, and R_D is the risk that the delivery does not take place [22]. The total risk perceived in a transaction, R, is thus given by $R = f(R_A, R_P, R_D)$. Liezenberg et al. [34] also point out that, one level lower, at each step in the transaction, the risk perceived by either actor is influenced by the 'transaction context', which is defined as "the total of situational circumstances" (o.c., p. 220). Liezenberg et al. distinguish four factors that constitute the transaction context: (i) the timeline (t) and order in which the processes are executed; (ii) the location (l)—physical or virtual; (iii) the relation (r) between buyer and seller—anonymous, known, or trusted[6]; and (iv) the characteristics of the product (p) that is exchanged. In symbols: $R_X = f(r_t, r_l, r_r, r_p)$; where X can be A, P, or D.[7]

Concerning r_l (the risk associated with the location of a transaction process) and r_r (the risk associated with the relation between buyer and seller), Liezenberg et al. point out, respectively, that virtual and/or distanced locations of the actors typically increase perceived risk, and that repetitive transactions typically entail a higher degree of trust than do incidental transactions. Given that the present paper only examines the online environment and given that in adopting an online payment method e-retailers always have to factor in that it can be used by a new, unknown

[4] There are other relevant papers. However, these papers are empirical in nature and do not really test a unified theoretical model. Instead they focus on a specific factor—costs, network externalities, etc.—and take a pragmatic approach in their selection of other explanatory variables. Again most papers overlook the role of risk; see [23, 35]. Bounie et al. [6], for their part, do include a card fraud variable in their regressions but do not find a significant impact on card acceptance by French merchants. The authors blame this on the fact that their variable is of an absolute nature and does not take into account the incidence of fraud with alternative payment instruments. Arango and Taylor [2] are another exception, but this paper is discussed lower in the main text.

[5] Note that in the published version of the Li et al. paper—Zhang and Li [64]—the theoretical model is no longer there.

[6] From a consumer perspective, this could be called vendor risk [34].

[7] See Fig. 3 in Liezenberg et al. [34] for a schematic presentation of the model.

customer, neither r_l nor r_r appear relevant for our research.[8] However, the two other factors clearly are.

Concerning r_t (the risk associated with the timing of a transaction), it is important to realize that in a traditional face-to-face retail setting, A, P and D are completed at the same time, in one place (A = P = D). As a result, the risk is shared equally between buyer and seller. Liezenberg et al. stress that with the introduction of distance selling (first mail order, then telephone order and now e-commerce), A, P and D "are disconnected in time and place, allowing for changes in the order of the processes and resulting in unbalanced risks for the buyers and sellers involved" (o.c., p. 220). That is, while a transaction always needs to start with an Agreement, the order of Payment and Delivery can be swapped. In case D comes before P (in a "pay afterwards" scenario: A = D → P or even A → D → P), the risk clearly rests with the seller, and vice versa. Finally, concerning r_p (the risk associated with product characteristics) Liezenberg et al. argue that the "core characteristics are the value (high/low) and substance (virtual/physical). In particular, the value of the product strongly determines Risk perceived by both actors. High-value products require more guarantees than do low-value products".[9]

Liezenberg et al. acknowledge that, besides risk, cost and usability also play a role, and that a certain choice of payment solution is an optimization over all three factors: "solutions with low risk come at higher costs than non-guaranteed payment solutions and may require more complex interaction for both buyer and seller" (o.c., p. 223). They are, however, convinced—but do not substantiate this claim—that "cost and usability considerations for buyer and seller are secondary to the risk assessment of the transaction, making (perceived) Risk the determining factor" (ibidem). In particular, Liezenberg et al. argue that, depending on the nature of their business, merchants perceive a certain degree of payment risk, R_P, "based primarily on Location, Relation and Product" and will then opt for "Payment/Delivery solutions with specific Timing to minimize the Risk for the seller" (ibidem).

In other words, Liezenberg et al. are convinced that, just like any economic agent, merchants tend to be risk averse. However, payment instruments are no ordinary goods. A merchant who refuses to accept a specific instrument stands to lose custom. Liezenberg et al. acknowledge this: "The seller also has to take into account the Risk of losing the transaction altogether, when no acceptable Payment and Delivery solutions are offered to the buyer" (ibidem). Merchants thus face a difficult balancing act, particularly so because "[t]he Risk perceived is different for buyer and seller: generally opposite, but not by definition" (ibidem).

In the present paper we set out to test the interaction between in particular the product and timing factors of payment risk (r_p and r_t), and also, one level higher, between payment risk and agreement risk (R_P and R_A). For reasons that will become clear below, we also look into the relationship between payment risk and delivery risk, R_D. More in general, we wanted to find out whether risk is effectively a key driver of (online) payment behavior, as Liezenberg et al. claim.

[8] Where r_l is concerned, this statement is qualified when developing our second hypothesis, in Sect. 5.1.

[9] In their experiment, Mascha et al. [37] use product price as the mechanism for manipulating r_p.

While the TCM has never been empirically tested before, there is some partial evidence in the existing literature, albeit primarily about real-world payment instruments and merchants. The paper by Arango and Taylor [2] is of particular interest, even though they analyze merchant preferences rather than actual acceptance. Arango and Taylor exploit the results of a stratified survey commissioned by the Bank of Canada and carried out amongst 500 (real-world) merchant representatives. The survey asked merchants, amongst other things, to rate cash, debit cards, and credit cards in terms of the risk of counterfeiting, theft, or fraud. For cash, Arango and Taylor find that higher perceived risk lowers merchant preferences (both in absolute terms and relative to debit cards), but that risk is non-significant for debit and credit cards. Another interesting result is that merchant acceptance levels do not reflect merchants' relative preferences. For example, when merchants who accept *all three* payment instruments surveyed were asked which one they prefer consumers to use the most often, 53 % favored debit cards, 39 % favored cash, and only 5 % favored credit cards—whereas they do accept them. Arango and Taylor also find that, as consumers use a payment instrument more intensively, merchants increasingly value their choice. For example, the more cash-oriented a merchant's business, the lower he will rank debit and credit cards (o.c., p. 16). These findings indicate that, within certain limits, merchants tend to take into account agreement risk and tend to accommodate consumer preferences [62]. In the same vein, Bounie et al. [6], in a study for France, find that the higher the probability that the average basket of a merchant is paid for by card in shops in the same sector and region, the higher the probability that the merchant will accept cards.

Given the balancing act between payment and agreement risk identified by Liezenberg et al., it is also interesting to have a look at empirical evidence on the consumer side. Do consumers care about payment risk? In a study for the Netherlands, Kosse [29] finds that newspaper articles about skimming fraud have a significant, albeit economically small, negative impact on same day debit card usage. The effect does not, however, sustain or accumulate in the long run.

In the US, the annual Survey of Consumer Payment Choice (SCPC) conducted by the Federal Reserve Bank of Boston asks respondents to evaluate payment instruments according to a set of payment attributes, one of which is security. The 2008–2012 versions of the SCPC broadly defined security as relating to both "permanent financial loss" and "unwanted disclosure of personal information" [57, p. 6]. The 2013 version split up the attribute into three characteristics: financial security—the only characteristic that is covered in the TCM—was explicitly separated from privacy, and there was also a question about the confidentiality of payment transactions themselves.

SCPC respondents consistently rank security as one of the most important characteristics of payment methods: in 2008–2012 security was ranked first; in 2013 it was ranked second. However, both Stavins [57] and Schuh and Stavins [55]—who analyse, respectively, the 2012 and 2013 SCPC data—find that the impact of perceived security on actual payment behavior is smaller than one would expect based on consumers' stated preferences. Concerns about (certain aspects of) security prove to have a significant negative effect on the adoption and/or use of certain payment instruments, but the effect of every other characteristic that is significant

(cost, convenience, etc.) is greater in magnitude—thus contradicting, at least for US consumers, Liezenberg et al.'s conjecture that risk is *the* determining factor.

Of particular interest for us is that Schuh and Stavins [55, p. 12] find that security of financial wealth has a significant impact on both the adoption and use of credit cards, as well as on the adoption (but not the use) of online banking bill payments and the use (but not the adoption) of debit cards. However, concerning cards, the authors stress that they "can be used in person, online, or on mobile devices, and that card use may occur through the use of payment services such as PayPal. Although card security may vary depending on location and/or device, our data do not allow us to estimate separate effects of security by location".

Stavins [57], for her part, does consider online purchases (excluding online bill payments) separately. She finds that consumers who rate credit cards as more secure—as measured by the combined security attribute—have a higher share of online credit card transactions, but again the impact of cost and convenience is both greater and more significant. Also, for prepaid cards and bank account payments the security rating has no significant effect on online purchases, and for debit cards there is even a negative effect. Overall, Stavins [57] attributes the modest effect of perceived security to the fact that consumers perceive differences in security across payment methods to be relatively small.

The limited evidence that is available for other countries does not yield insights into the relative importance of perceived security, but does suggest that it is a relevant determinant of payment choice. Kim et al. [26] find, based on survey data, that perceived security is positively related to Korean online consumers' usage of "e-payment systems" (broadly defined). Perceived security also has an indirect impact on usage via its impact on perceived trust. Finally, for our purposes a particularly interesting consumer study is Hu et al. [20]. Hu et al. conduct an experiment in which 30 participants from a Chinese university are shown 8 ($2 \times 2 \times 2$) variations of a simplified Amazon web page. One of the factors that are varied is the price level: high (RMB 800) versus low (RMB 200). Participants were instructed to indicate which of three payment methods (debit, credit, or pay on delivery) they would use to pay for the product shown. Hu et al. find that pay on delivery is more likely to be chosen when product uncertainty or the price is high.[10] This is an interesting result because, as we will argue in the next section, if online consumers are risk averse, pay on delivery can effectively mitigate the concerns of both consumers and merchants. This is crucial because, as Liezenberg et al. [34, p. 223] point out, a transaction can only happen if "both buyer and seller have agreed a mutually accepted balance for risk, cost and usability".

4 Finality and risk of payment instruments

As has become clear in the previous section, an application of the TCM requires insight into the risks associated with individual payment instruments and how these risks are distributed between buyer and seller. In particular, a test of Liezenberg

[10] Product uncertainty is defined as "the difficulty of buyers in evaluating the characteristics and future performance of products" [20, p. 2].

et al.'s claim that merchants will opt for payment solutions with specific Timing—in order to mitigate payment risk stemming from Location, Relation or Product—raises the question *which* payment methods minimize r_t for the seller. In essence, the answer to this question depends on whether payments become 'final'—that is, irreversible—before, at the same time as, or after delivery.[11]

At the end of their article, Liezenberg et al. [34] apply their framework to a number of context examples and score the most commonly used payment solutions context per context. Given that the present paper focuses on the impact of the Product factor, the example that is most relevant for our purposes is the one about an online purchase of a design clock with a "high value" of EUR 199 (o.c., Table 1, p. 224). For this context, Liezenberg et al. identify bank transfers as low-risk for the seller, and credit cards as high-risk (o.c., Table 3, p. 225). The reason is that the first are guaranteed (in part because P takes place before D) and the second not. Indeed, even though surfers who pay by credit card have to enter their card details online, so that here too P seemingly takes place prior to D, in reality the payment only becomes final later. This is because credit card customers can—legitimately or not—reverse a transaction, resulting in a 'chargeback' (the return of funds to the consumer). Credit cards are thus 'pay afterwards'.[12] As Zhang and Li [63] explain—for the case of the US—"under the Fair Credit Billing Act, buyers have the right to withhold payment on poor-quality or damaged merchandise purchased with a credit card." Credit card buyers can also (claim to) be the victims of fraud, in which case the seller has to refund the sales price, loses the product, cannot recover the original transaction fee, and even faces a new transaction fee for the reverse payment. According to Zhang and Li, in the US such chargeback fees typically range from USD 10 to USD 20.[13]

Looking at other instruments, it is important to note that the timing of online payments with debit cards or prepaid electronic money is favorable for the seller because, just like bank transfers, A and P coincide and precede D. Cash on delivery (COD) of physical goods corresponds with generic timing type 3a in Liezenberg et al.'s Fig. 2 (o.c., p. 221); that is, $A \rightarrow D = P$. Because there is a 'simultaneous handover' ($D = P$), the payment risk for the seller is low. There is, however, an agreement risk. The buyer might on the spot call off the transaction and refuse to

[11] There is a link here with the well-known classification of payment instruments as "pay before", "pay now", or "pay later". However, this distinction only relates to the settlement of the transaction *from the payer's perspective* and does not necessarily reveal much about the chronological sequence of payment and receipt of the goods. Indeed, a consumer who pays by means of an online bank transfer uses a *pay now* payment instrument in terms of settlement: her current account is debited immediately. But in terms of the A–P–D sequence, she in fact pays first and will receive the goods only a couple of days later. In other words, in the TCM such a scenario classifies as "pay in advance" [34, Fig. 2, p. 221].

[12] Hu et al. [20, p. 2] erroneously classify credit cards as "pay-before delivery", together with debit cards.

[13] More generally, the Zhang and Li [64] article contains an interesting Table—Table 1 on p. 1079—that provides an overview, for the case of the US, of the protection that individual payment methods provide to both buyers and sellers. Zhang and Li's conclusion from the table is straightforward: for buyers, credit cards provide more protection than cash-equivalents such as cash, money order, cashier's check, etc.; for sellers, it is the opposite. Given the higher card fraud levels, this holds *a fortiori* in the countries that we study.

pay—for a number of reasons, both real (she is disappointed with the good) or invented (she has second thoughts). If this happens, the seller not only loses a sale but also incurs a loss in delivery cost. The latter is also true when the address is wrong. This probably explains why, on a ++ to − scale, Liezenberg et al. give cash a '-' for seller risk in their 'pizza order via telephone' scenario (o.c., Table 7, p. 226). Note that they score credit cards '−' in the design clock example.

Evidence on how merchants perceive the risk of payment instruments in reality is scarce. We are only aware of Arango and Taylor [2, p. 9], who, for the case of Canada (and with a focus on real-world payments), note that debit cards were viewed as the least risky, with 42 % of merchants rating them as 'not at all risky'. As already mentioned in Sect. 3, Stavins [57, p. 9], reports that US *consumers*, for their part, perceive differences in security across payment methods to be relatively small. For our purposes what stands out is that, in line with the analysis above, credit cards received the second-highest rating (after online banking bill payments), but that, surprisingly, the average credit card and debit card ratings were not significantly different from each other. Another interesting result is that 63 % of consumers viewed in-person payments as 'very secure', compared with only 10.2 for online payments (ibidem, p. 11).

5 Hypotheses

5.1 Main hypotheses

As mentioned in Sect. 3, with the data that we have we cannot test the impact of the Location or Relation factors on merchant payment choice. We therefore focus on the interaction between the Product and Timing factors. As will be explained in Sect. 6, we have first classified the 194 sites in our dataset into sectors and subsequently grouped the sectors into categories, based on an assessment of whether the average transaction amount in the sector is low, medium, or high; in other words, based on the level of r_p. In line with the TCM, our conjecture is then that sites active in a sector with high transaction amounts and thus potentially high payment risk, R_P, will try to mitigate this by avoiding payment methods with unfavorable timing for the seller. In other words, sellers will opt for methods that put the payment and/or the agreement risk with the buyer, or where the risks are shared. Hence our H1 reads:

H1 the higher their average transaction value, the lower the probability that e-retailers will adopt payment methods with unfavorable timing for the seller.

Given the analysis in Sect. 4, in practice one would thus expect e-retailers active in a sector with high product value to be less inclined to accept credit cards, and more inclined to accept debit cards or other low-risk payment methods.

Moving from payment risk, R_P, to delivery risk, R_D, our second core hypothesis reads:

H2 e-retailers who offer high-risk delivery methods are more likely to adopt high-risk payment methods.

The rationale behind H2 is straightforward: we see e-retailers who only offer low-risk delivery methods as relatively risk-averse and we expect this to be reflected in their choice of payment methods. For example, one would expect merchants who prefer to rely on in-store pick-up to also have a higher preference for COD, which has a lower payment risk than credit cards because buyer and seller 'cross the bridge' at the same time. COD in effect turns a virtual into a physical transaction, thus lowering r_t and r_l—and ultimately both R_P and R_D [34],[14] but as pointed out in Sect. 4 not necessarily R_A. Note that the relationship to be tested in H2 need not be symmetric; on the contrary even. Indeed, e-retailers who have no problem offering high-risk delivery methods are probably happy to accept low-risk payment methods (as well).

5.2 Other determinants

Although the focus of the paper is on the role of risk, there are obviously several other potential determinants of the adoption of online payment methods by B2C websites. We thus have to control for these factors. To start on the country level, it is clear that whatever the infrastructure of a country, providing payment options that are familiar as well as convenient to customers is a must for e-retailers [56]. In terms of the TCM: e-retailers have to take into account the agreement risk. Prior research confirms that the popularity of a particular payment method among prospective customers is an important determinant of its acceptance by online merchants; see Polasik and Fiszeder [51] for the case of Poland. Hence, in view of the dramatic inter-country differences in penetration rates observed in Table 1, we expect the degree of (offline) penetration of a payment instrument to positively affect its adoption by e-retailers.

A further justification of this hypothesis can be found in the network externalities theory. Network goods are "products for which the utility that a user derives from consumption of the good increases with the number of other agents consuming the good" [25]. Applied to payment instruments, the network externalities theory implies that consumers will not use a payment instrument as long as they can only pay with it in a limited number of shops, whereas merchants will be reluctant to invest in equipment or software needed to accept it unless (they think that) a sufficient number of customers will be interested [61].

We also control for two additional (and intuitive) factors, both of which are situated on the website level. For one, merchants who want to sell to foreign markets by definition need to adopt international payment options, credit cards being the prime example. Such merchants might also, as Polasik and Fiszeder [51] find for the case of Poland, see less need to accept "methods based on domestic settlement

[14] It goes without saying that this can be mutually beneficial for seller and buyers, as anecdotal evidence for Nigeria shows: "Millions of people in [Lagos] are prospering and many are shopping online for the first time. But in a country that has become synonymous with online fraud, they would sooner hand money to a courier than enter their credit-card numbers on a website. So online shopping site DealDey.com employs of fleet of motorcyclists to dart through gridlocked streets to meet online shoppers waiting to pay for their purchases with cash" [19]. There is a clear link here with Stavins' [57] finding, mentioned in Sect. 4, that 63 % of US consumers view in-person payments as 'very secure'.

systems or personal contact". Secondly, apart from home delivery, only e-retailers with an offline presence have the ability to allow for payment in person—potentially by means of a range of instruments (cash, debit cards, etc.)—and, conversely, might be less inclined to accept online payment solutions.

On a final note, let us stress that we were unable to take into account a number of potential determinants simply because we lacked (sufficiently detailed) data. For one, as pointed out by Liezenberg et al., there is usability. While usability is unlikely to differ on the site or sector level, it might matter on the country level. For example, the countries that we study have different e-money solutions. Also, for payment instruments that are *in se* identical across countries, such as credit cards, security measures might differ. We did try country dummies to capture this, but these did not yield meaningful results. In order to check for an omitted macro-level factor, we also ran our regressions for subsets of countries and for individual countries. Except for pay-roll cards—which are only available in two countries anyway—these robustness checks are only briefly reported in footnotes.

The most glaring omission on our list of variables are the costs associated with the payment instruments, both variable and fixed. These costs can even differ from one merchant to the next because of, respectively, volume discounts and economies of scale. That costs affect merchant acceptance is well-documented, at least for real-world merchants. For example, Bounie et al. [6] find that both fees and fixed costs—proxied by turnover and number of transactions—exert a strong influence on the probability of card acceptance by French merchants. Where online merchants are concerned, Polasik and Fiszeder [51], in their study for Poland, just like us do not have hard data on the costs involved, but did ask online shops managers to ascribe percentage weights to a list of factors—including fixed costs and commissions—that influence their decision to adopt a payment instrument. The results are mixed: both variables only yield significant results for two out of the seven instruments considered. We come back on the impact of costs in our discussion of the results in Sect. 6.

Finally, size of the e-retailer would be a logical control variable for reasons other than costs too. One could, for example, argue that larger firms have the human resources to support a wider range of payment methods, including the more labor-intensive ones. As a matter of fact, Arango and Taylor [2, p. 8] find that "the smallest merchants (measured either in terms of number of employees or sales volume) are the least likely to accept electronic payments". To be clear: there are no Internet-only merchants in Arango and Taylor's dataset. Conversely, Polasik and Fiszeder [51] find no evidence whatsoever that the number of employees impacts the acceptance of online payment methods. Unfortunately, we cannot control for size because we lack the data.

6 Methodology

6.1 Data collection

Where the data is concerned, in June–August 2010 we set out to content analyze all B2C websites in five Central Asian countries. Following [13] and [24], to identify

the sites we first systematically screened the local trade portals (e.g., http://www.uz) and business directories (i.e., Yellow and Golden Pages). Next, we performed keyword searches on search engines such as Google and Yandex. The descriptors used in the searches included: e-commerce, online shop, e-shop, online retail, e-tail (alternately combined with Kazakhstan; Kyrgyzstan; Tajikistan; Turkmenistan; and Uzbekistan). The keyword searches were performed in English, Russian, as well as in local languages. The majority of the websites were found on local web trade portals and on the Russian search engine Yandex. Also, most were in Russian (a language mastered by one of the authors, along with most local languages).

Our initial search produced a total of 308 hits (distributed as follows: Kz = 170; Kg = 49; Tj = 22; Tm = 12; Uz = 55), all of which were subsequently examined for relevancy. We eliminated all non-transactional websites (that is, sites that did not allow for instant order placement and did not provide payment or delivery options) as well as sites outside the B2C sector. Eventually 194 sites were left (with: Kz = 126; Kg = 23; Tj = 6; Tm = 3; Uz = 36). As we have endeavored to make our search as extensive as possible, this dataset should cover just about the entire population of relevant sites at the time, but we can obviously never be entirely sure.

In order to obtain the information on payment and delivery methods that we needed, we analyzed the content of the sites in two stages: we first investigated the *Help* or *FAQ* pages and subsequently set up an account and placed an order (without really going through the check-out). Since the presence of a payment/delivery option is straightforward to observe and code (absence = 0; presence = 1), we saw no need to have the data independently recorded by multiple observers (cf. [16]) and we relied on a single visit. Table 3 provides an overview of the codes used.

6.2 Descriptive data on the acceptance of online payment methods

Table 4 and Fig. 1 show that—even though they can only be used by domestic consumers—81 % of the sites accepted at least one paper-based offline payment method in 2010 (see ANYP). Especially bank transfers and COD are popular options, with overall adoption rates of 76 and 42 %, respectively. To clarify: a paper-based bank transfer will typically require customers to go to the bank designated by the e-retailer to initiate a money transfer to the vendor's account. Paying at the post office is limited to Kazakh sites. Note that per-country penetration rates can vary from the single to the double and even more—although the low number of observations for Tajikistan and Turkmenistan calls for prudence. For the three other countries, we performed χ^2 and ANOVA tests to check for differences (1) in the proportion of sites that accept a given paper-based instrument, and (2) in the mean number of paper-based instruments. None of the differences proved to be statistically significant ($p > 0.05$), with the obvious exception of paying at the post office (cf. supra).

All this indicates that B2C sites in Kazakhstan, Kyrgyzstan and Uzbekistan by and large behave similarly in adopting paper-based instruments, probably due to similarities in the environment. In our analysis we therefore focus on electronic instruments, where the differences are greater. Credit cards, for example, are almost exclusively accepted in Kazakhstan and Uzbekistan. The latter is a mild surprise,

Table 3 Payment and delivery variables

Category	Code	Subcategory
Payment methods		
Credit card	C1	Visa (0/1)
	C2	MasterCard (0/1)
	C3	American Express (0/1)
	C4	Diners Club (0/1)
	C5	Discover (0/1)
	C6	JCB (0/1)
	ANYC	= C1 *or* C2 … *or* C6; binary (0/1)
	TOTALC	= C1 + C2 ··· + C6; integer, ranges between 0–6
Debit card	D1	Visa Electron (0/1)
	D2	Maestro (0/1)
	D3	Payroll card (0/1)
	ANYD	= D1 *or* D2 *or* D3; binary (0/1)
	ANY(D1 + D2)	= D1 + D2; binary (0/1)
	TOTALD	= D1 + D2 + D3; integer, ranges between 0–3
ANY(C + D)		= ANYC *or* ANYD; binary (0/1)
TOTAL(C + D)		= TOTALC + TOTALD; ranges between 0–9
E-Money	E1	PayPal (0/1)
	E2	WebMoney (0/1)
	E3	ePay (0/1)
	E4	Other e-money (0/1)
	ANYE	= E1 *or* E2 … *or* E4; binary (0/1)
	TOTALE	= E1 + E2 … + E4; integer, ranges between 0–4
Paper-based	P1	Cash-on-delivery (0/1)
	P2	Bank transfer (offline) (0/1)
	P3	Pay at post office (0/1)
	P4	Other paper-based (0/1)
	ANYP	= P1 *or* P2 … *or* P4; binary (0/1)
	TOTALP	= P1 + P2 … + P4; integer, ranges between 0–4
TOTALCAT		= ANYC + ANYD + ANYE + ANYP; integer, ranges between 0–4
TOTALALL		= TOTALC + TOTALD + TOTALE + TOTALP; integer, ranges between 0–17
Delivery services		
LOGISTICS_PRIVATE		Private delivery (0/1)
LOGISTICS_POSTAL		National mail (0/1)
LOGISTICS_COURIER		Courier service (0/1)
LOGISTICS_INSTORE		In-store pick-up (0/1)
LOGISTICS_OTHER		Other delivery methods (0/1)

In the codes, *C* stands for 'credit card', *D* for 'debit card', etc

Table 4 Payment options provided by B2C e-commerce websites

Category	Subcategory	KZ n (%)[a]	KG n (%)[a]	TJ n (%)[a]	TM n (%)[a]	UZ n (%)[a]	Total n (%)[b]
Credit cards	Visa	25 (19.8)	1 (4.3)	0 (0.0)	0 (0.0)	7 (19.4)	33 (17.0)
	MasterCard	24 (19.0)	1 (4.3)	0 (0.0)	0 (0.0)	7 (19.4)	32 (16.5)
	American Express	6 (4.8)	0 (0.0)	0 (0.0)	0 (0.0)	5 (13.9)	11 (5.7)
	Diners Club	4 (3.2)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	4 (2.1)
	Discover	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (2.8)	1 (0.5)
	JCB	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (2.8)	1 (0.5)
	ANYC	25 (19.8)	1 (4.3)	0 (0.0)	0 (0.0)	7 (19.4)	33 (17.0)
Debit cards	Visa Electron	11 (8.7)	1 (4.3)	0 (0.0)	0 (0.0)	0 (0.0)	12 (6.2)
	Maestro	12 (9.5)	0 (0.0)	0 (0.0)	0 (0.0)	1 (2.8)	13 (6.7)
	Payroll card	2 (1.6)	0 (0.0)	0 (0.0)	0 (0.0)	16 (44.4)	18 (9.3)
	ANYD	16 (12.79)	1 (4.3)	0 (0.0)	0 (0.0)	16 (44.4)	33 (17.0)
	ANY(D1 + D2)	16 (11.9)	1 (4.3)	0 (0.0)	0 (0.0)	1 (2.8)	17 (8.8)
	ANY(C + D)	25 (19.8)	1 (4.3)	0 (0.0)	0 (0.0)	22 (61.1)	48 (24.7)
E-money	PayPal	3 (2.4)	0 (0.0)	0 (0.0)	1 (33.3)	6 (16.7)	10 (5.2)
	WebMoney	24 (19.0)	2 (8.7)	3 (50.0)	1 (33.3)	11 (30.6)	41 (21.1)
	ePay	11 (8.7)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	11 (5.7)
	Other e-money	5 (4.0)	0 (0.0)	0 (0.0)	1 (33.3)	1 (2.8)	7 (3.6)
	ANYE	36 (28.6)	2 (8.7)	3 (50.0)	1 (33.3)	13 (36.1)	55 (28.4)
Paper-based	Cash-on-delivery	99 (78.6)	16 (69.6)	6 (100.0)	1 (33.3)	25 (69.4)	147 (75.8)
	Bank transfer	54 (42.9)	6 (26.1)	3 (50.0)	2 (66.7)	17 (47.2)	82 (42.3)
	Pay at post office	14 (11.1)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	14 (7.2)
	Other paper-based	17 (13.5)	2 (8.7)	0 (0.0)	0 (0.0)	0 (0.0)	19 (9.8)
	ANYP	108 (85.7)	16 (69.6)	6 (100.0)	2 (66.7)	25 (69.4)	157 (80.9)
Number of websites		126	23	6	3	36	194

Source Authors' own compilation based on self-collected dataset

[a] Number and percentage of websites in a country that accept a payment option

[b] Number and percentage of the total number of websites that accept a payment option

given that the bulk of the cards issued in Uzbekistan are actually debit cards (i.e., payroll cards), many of which cannot be used online (see Sect. 2). As will be demonstrated in Sect. 7, the explanation lies with Uzbek sites that target international markets. The picture for debit cards is similar. Again they are accepted almost exclusively in Kazakhstan and Uzbekistan, be it that the type differs: Visa Electron and Maestro in Kazakhstan versus local payroll cards in Uzbekistan.[15]

Where e-money is concerned, it can be seen that options such as WebMoney, ePay, and PayPal are widely accepted by sites in Kazakhstan and Uzbekistan, and to

[15] Kz = 12.8 % and Uz = 44.4 %, compared to Kg = 4.3 %; χ^2-test $p < 0.000$.

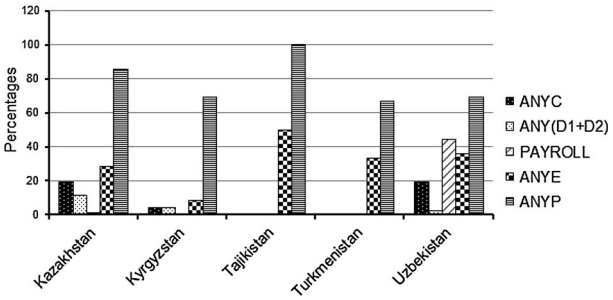

Fig. 1 Adoption of payment methods by B2C e-retailers. *Source* Authors' own compilation based on self-collected dataset

a lesser extent by Kyrgyz B2C ventures (two sites).[16] A χ^2 test for ANYE shows that the difference in adoption between the three countries is moderately significant.[17] This could be due to the higher development of the non-banking sector of instant payments in Uzbekistan, where there are several e-money schemes such as Paynet, E-pay, Fast-pay, Unipay, Cyberplat, WebMoney, Mobliss, PayCarta, and the national eKarmon system [21]. These instruments, which not only allow to purchase goods from online stores, but also to top-up mobile phone credit and pay for Internet access or international telephony services, are becoming increasingly popular.

In Sect. 7, we try to explain the adoption of a selection of the above payment methods by means of logit analysis. In the next subsection we first explain the construction of our explanatory variables. Detailed definitions and data sources can be found in Table 9 in Appendix. Descriptive statistics can be found in Table 10, and correlations in Tables 11 and 12.

6.3 Construction of explanatory variables

Our core variables obviously relate to risk. For one, to construct a proxy for (one aspect of) Liezenberg et al.'s r_p, we first relied on the InternetRetailer website[18] to classify the 194 sites in our dataset into 15 sectors and subsequently grouped the sectors into three categories, based on an assessment of whether the average transaction amount in the sector is low, medium, or high. In order to do this as objectively as possible, we followed a multiple-rater approach. Three individuals—the two authors and a marketing colleague specialized in retailing—first rated all sectors independently. On comparing the individual ratings, it emerged that there

[16] The classification of PayPal as 'e-money' can be criticized, as the current version of PayPal is mainly used not as an electronic wallet but rather as a way for small merchants to indirectly accept credit cards. However, we specifically did not want to lump PayPal together with the straightforward acceptance of credit cards. This said, we did run robustness checks by reclassifying PayPal as a credit card; cf. infra.

[17] Kz = 28.6 % and Uz = 36.1 % vs. Kg = 8.7 %; χ^2-test p = 0.065.

[18] See http://www.internetretailer.com/top500/.

was immediate agreement on 11 of the 15 sectors. The disagreements were resolved by jointly revisiting a random selection of sites in the four sectors concerned. This second round also impelled us to split up the sector 'Housewares/Home Furnishings' into two separate sectors, as there proved to be substantial differences in the products listed. A complete list of the sectors, together with their classification, can be found in Table 13.

It is clear that our proxy—which we termed TRX_SIZE—can be criticized. We realize that the price range of products in a sector can be quite large and that, as a result, the price ranges of different sectors can, and in many cases will, overlap. For instance, certain computer parts and accessories (categorized as 'high' in our classification) might be cheaper than some health and beauty products (that are categorized as 'low'). However, what we try to capture is not so much inter-sector differences in product values, but rather in transaction sizes. In their model, Liezenberg et al. [34] may reason in terms of an individual product—cf. "the value of *the product*" in Sect. 3—in reality risk is determined by the content of the shopping cart. Also, e-retailers typically cannot (or will not) prevent customers from using a specific payment instrument for higher transaction values: once a web merchant accepts a certain risky payment instrument, the risk is *de facto* not limited to low-value orders. Hence, one needs to take into account the full price range of the sector. Given that fraudsters have an incentive to maximize the value of their order—without, however, raising suspicion—it could even be argued that the upper part of the price range is more relevant. Such fraud behavior also throws a different light on the fact that our proxy is measured at the sector level (and thus ignores possible heterogeneity among e-retailers within a sector). Clearly, directly asking merchants about average transaction size and/or perceived risk would have been more objective, but an *ex ante* small-scale test indicated that response levels would be very low, resulting in a loss of too many observations.[19]

Importantly, we tried two variants of our TRX_SIZE variable: one with three categories, as just explained, as well as a binary variable in which the 'medium' and 'high' categories were merged. Note that all four initial rater disagreements related to whether the sector should be rated 'medium' or 'high'. In other words, for the binary TRX_SIZE variable there was full agreement from the start. Also, this approach is not dissimilar from the one followed by Basu and Muylle, who, in their studies for the US [5, 42], distinguish industries selling inexpensive and expensive products based on whether the average sales price is less than USD 50 or not.[20] Our binary variable proved to yield the stronger results and is therefore the one that we concentrate upon hereafter. When the alternative variable gave different results, this is indicated explicitly.

In order to be able to test our second hypothesis, we also needed to construct an index for the risk associated with the delivery methods used by our e-retailers. In doing do, we considered electronic delivery, in-store pick-up, and private delivery

[19] After the facts we did send out an e-mail survey—in order to, at the very least, be able to check whether our ratings made sense. As anticipated, we only received six complete responses out of a total of 181 surveys sent. Of these six responses, five were consistent with our coding and one was not.

[20] Note that reusing the industry classification of Basu and Muylle [5] was not an option as their sectors do not cover all the product categories that we encountered.

to be low-risk (value = 1), as the e-retailer remains fully in control. We assumed that outsourcing, even to reliable partners, increases the risk. Specifically, we deemed the use of courier services to be medium-risk (value = 2), and the use of the national postal system—which is reportedly not very reliable, see Sect. 2—to be high-risk (value = 3). In our DELIVERY_RISK variable, every merchant was then given a 'risk coefficient' corresponding to the highest-risk delivery method that he uses. For example, a merchant who, amongst other methods, makes use of courier services, but not of the postal system, received a 2.[21]

Turning to our control variables, we were only able to quantify the degree of (offline) penetration of payment cards and bank accounts. For e-money products we lacked the data; see Table 1. For cards, we constructed several variants, so as to be able to focus on specific types. For one, %CARDS_INTERNAT is the total number of international cards in circulation divided by total population. %CARDS_LOCAL is a similar variable for local cards. An important drawback of %CARDS_INTERNAT is that it does not distinguish between credit and debit cards. We therefore relied on the World Bank's *Global Financial Inclusion (Global Findex) Database* and the EBRD's *Life in Transition (LiTS) survey II* to construct more specific variables; see Table 9 for details and Table 1 for numbers. Since the penetration of payment instruments is often linked with the level of economic development, we also tried GDP per capita (GDPCAP) and the Human Development Index (HDI) as alternative country variables.

All other remaining variables are simple binary dummies. OFFLINE_PRESENCE equals 1 for bricks-and-clicks merchants, and 0 for so-called pure-plays. INTERNAT_CUR, INTERNAT_LNG, and INTERNAT_DELIV are three alternatives that try to gauge whether a site targets international markets or not, resp. by looking at whether prices are (also) mentioned in foreign currency, whether the site is (also) available in a foreign language, and whether the site states explicitly that they deliver internationally. Finally, LOGISTICS_COURIER and the like are simply ways to test links between payment and delivery methods on the individual level, rather than merely in the aggregate—by means of DELIVERY_RISK.

7 Results

In Tables 5, 6, 7, 8 we report our logistic regression results in the most obvious way; that is, payment instrument by payment instrument. We do not, however, discuss them in this order. Rather we discuss them per explanatory variable, across payment instruments. We start with the predictor variables that are directly related to our hypotheses, namely TRX_SIZE (in Sect. 7.1) and DELIVERY_RISK (in Sect. 7.2). Next we briefly discuss the control variables (in Sect. 7.3).

Note that we have not tried to explain the adoption of all payment instruments listed in Table 3. As explained in Sect. 6.2, the inter-country variation in the acceptance of paper-based instruments (ANYP) is low. Moreover, ANYP is a very diverse category. Of the paper-based instruments, we therefore only cover COD.

[21] We also ran a robustness check with a set of three dummy variables. This yielded similar results.

Table 5 Determinants of ANYC (all countries; N = 194)

Dependent variable	ANYC								
Specification	1	2	3	4	5	6	7	8	9
Site-specific variables									
CONSTANT	−947	−0.672	−0.352	−1.261	−1.027	−0.655	−1.783*	−1.743*	−1.120
Sig.	(0.304)	(0.430)	(0.665)	(0.203)	(0.250)	(0.450)	(0.073)	(0.064)	(0.211)
OFFLINE_PRESENCE	−0.686*	−0.808**	−0.865**	−0.831*	−0.936**	−0.950**	−0.829*	−0.942**	−0.949**
Sig.	(0.100)	(0.050)	(0.044)	(0.056)	(0.031)	(0.032)	(0.057)	(0.030)	(0.031)
INTERNAT_CUR	1.181**			1.058*			0.958		
Sig.	(0.047)			(0.095)			(0.120)		
INTERNAT_LNG		1.042*			1.094*			1.102**	
Sig.		(0.051)			(0.051)			(0.048)	
INTERNAT_DELIV			1.975***			1.683***			1.585**
Sig.			(0.001)			(0.009)			(0.014)
LOGISTICS_COURIER				1.538***	1.662***	1.362**			
Sig.				(0.006)	(0.004)	(0.017)			
DELIVERY_RISK							0.930***	1.022***	0.768**
Sig.							(0.006)	(0.003)	(0.027)
Sector-specific variables									
TRX_SIZE	−1.225***	−1.176***	−1.246***	−1.460***	−1.460***	−1.467***	−1.392***	−1.367***	−1.394***
Sig.	(0.004)	(0.006)	(0.004)	(0.001)	(0.001)	(0.001)	(0.002)	(0.003)	(0.002)
Country-specific variables									
%CARDS_CREDIT_FINDEX	0.216***	0.180**	0.147**	0.169*	0.130*	0.111	0.132	0.101	0.091
Sig.	(0.010)	(0.016)	(0.050)	(0.051)	(0.090)	(0.150)	(0.134)	(0.209)	(0.253)
Valid observations	194	194	194	194	194	194	194	194	194

Table 5 continued

Dependent variable	ANYC								
Specification	1	2	3	4	5	6	7	8	9
Model fitting information									
− 2 Log likelihood	156.059	156.338	149.436	146.954	146.040	142.742	147.978	146.612	144.328
χ^2	20.888***	20.610***	27.511***	29.993***	30.907***	34.206***	28.970***	30.336***	32.619***
df	4	4	4	5	5	5	5	5	5
Sig.	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Hosmer and Lemeshow test									
χ^2	3.072	1.039	1.505	6.859	3.123	5.642	8.341	6.246	10.629
df	6	6	7	8	8	7	7	7	8
Sig.	(0.800)	(0.984)	(0.982)	(0.552)	(0.926)	(0.582)	(0.303)	(0.511)	(0.224)
Pseudo R^2									
Cox & Snell R	0.102	0.101	0.132	0.143	0.147	0.162	0.139	0.145	0.155
Nagelkerke R^2	0.171	0.168	0.221	0.239	0.246	0.270	0.232	0.242	0.259
Percentage correct									
% correct P = 1	6.1	6.1	21.2	18.2	21.2	27.3	18.2	21.2	24.2
% correct P = 0	100.0	98.8	98.8	97.5	98.1	97.5	99.4	99.4	98.8
% overall correct	84.0	83.0	85.6	84.0	85.1	85.6	85.6	86.1	86.1

Regressions were run with binary logit. *P* values are reported in parentheses. *, **, *** Significance levels of 10, 5, and 1 % respectively

Table 6 Determinants of PAYROLL (a = UZ, N = 36; b = UZ & KZ, N = 162)

Dependent variable	PAYROLL (a)						PAYROLL (b)					
Specification	1	2	3	4	5	6	7	8	9	10	11	12
Site-specific variables												
CONSTANT	−3.946**	−5.683**	−4.754**	−3.358	−5.713**	−4.927**	−9.036***	−9.957***	−10.437***	−10.607***	−12.004***	−12.106***
Sig.	(0.037)	(0.017)	(0.013)	(0.104)	(0.023)	(0.015)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
OFFLINE_PRESENCE	1.459	1.910**	1.811**	1.614*	1.905**	1.740*	0.969	1.429*	1.552**	0.889	1.343*	1.413*
Sig.	(0.118)	(0.025)	(0.036)	(0.098)	(0.028)	(0.053)	(0.232)	(0.057)	(0.045)	(0.279)	(0.079)	(0.073)
INTERNAT_CUR	−2.394*			−2.684**			−2.497**			−2.277*		
Sig.	(0.051)			(0.046)			(0.040)			(0.061)		
INTERNAT_LNG		0.610			0.605			0.322			0.084	
Sig.		(0.673)			(0.677)			(0.789)			(0.947)	
INTERNAT_DELIV			−18.618			−18.890			1.241			0.566
Sig.			(0.999)			(0.999)			(0.324)			(0.682)
DELIVERY_RISK				−0.729	0.035	0.259				0.855	1.065	0.965
Sig.				(0.515)	(0.969)	(0.788)				(0.264)	(0.140)	(0.204)
Sector-specific variables												
TRX_SIZE	2.139**	2.600**	2.169**	2.357**	2.593**	2.096**	2.191**	2.443**	2.546***	2.079**	2.328**	2.427**
Sig.	(0.035)	(0.032)	(0.027)	(0.032)	(0.035)	(0.039)	(0.023)	(0.022)	(0.008)	(0.032)	(0.032)	(0.014)
Country-specific variables												
%CARDS_LOCAL	[a]	[a]	[a]	[a]	[a]	[a]	0.212***	0.195***	0.204***	0.238***	0.231***	0.231***
Sig.							(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Valid observations	36	36	36	36	36	36	162	162	162	162	162	162
Model fitting information												
− 2 Log likelihood	29.769	34.545	34.334	29.325	34.543	34.262	50.378	56.032	55.284	49.097	53.732	53.578
Chi Square	19.692***	14.917***	15.127***	20.136***	14.918***	15.199***	62.643***	56.990***	57.737***	63.924***	59.289***	59.444***
df	3	3	3	4	4	4	4	4	4	5	5	5
Sig.	(0.000)	0.002	(0.002)	(0.000)	(0.005)	(0.004)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)

Table 6 continued

Dependent variable	PAYROLL (a)						PAYROLL (b)					
Specification	1	2	3	4	5	6	7	8	9	10	11	12
Hosmer and Lemeshow test												
χ^2	18.160***	9.122**	11.043	28.860***	10.178*	12.086	12.813	7.097	14.350**	5.149	10.857	6.400
df	4	3	3	5	5	6	6	6	7	8	8	8
Sig.	(0.001)	(0.028)	(0.011)	(0.000)	(0.070)	(0.060)	(0.046)	(0.312)	(0.045)	(0.742)	(0.210)	(0.603)
Pseudo R^2												
Cox & Snell R	0.421	0.339	0.343	0.428	0.339	0.344	0.321	0.297	0.300	0.326	0.306	0.307
Nagelkerke R^2	0.564	0.454	0.459	0.574	0.454	0.461	0.639	0.590	0.597	0.649	0.610	0.612
Percentage correct												
% correct P = 1	87.5	75.0	75.0	87.5	75.0	75.0	77.8	66.7	66.7	77.8	66.7	66.7
% correct P = 0	85.0	95.0	95.0	95.0	95.0	95.0	97.9	93.3	99.3	97.9	97.9	97.9
% overall correct	86.1	86.1	86.1	91.7	86.1	86.1	95.7	95.7	95.7	95.7	94.4	94.4

[a] Only Uzbekistan is included in models 1–6, so %CARDS_LOCAL is constant

Regressions were run with binary logit. P values are reported in parentheses. *, **, *** Significance levels of 10, 5, and 1 % respectively

Table 7 Determinants of ANYE (all countries; N = 194)

Dependent variable	ANYE					
Specification	1	2	3	4	5	6
Site-specific variables						
CONSTANT	−6.043**	−1.326	−0.068	−4.292	0.420	1.214
Sig.	(0.045)	(0.579)	(0.997)	(0.170)	(0.867)	(0.626)
OFFLINE_PRESENCE	−1.220***	−1.340***	−1.400***	−1.315***	−1.436***	−1.457***
Sig.	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
INTERNAT_CUR	2.424***			2.350***		
Sig.	(0.000)			(0.000)		
INTERNAT_LNG		0.875*			0.936*	
Sig.		(0.075)			(0.064)	
INTERNAT_DELIV			1.789***			1.444**
Sig.			(0.005)			(0.029)
DELIVERY_RISK				0.748**	0.839***	0.647**
Sig.				(0.013)	(0.004)	(0.028)
Sector-specific variables						
TRX_SIZE	−0.184	−0.299	−0.338	−0.328	−0.424	−0.459
Sig.	(0.648)	(0.430)	(0.372)	(0.427)	(0.274)	(0.234)
Country-specific variables						
HDI	8.295*	2.164	0.403	4.102	−2.357	−2.876
Sig.	(0.053)	(0.530)	(0.908)	(0.377)	(0.541)	(0.455)
Valid observations	194	194	194	194	194	194
Model fitting information						
− 2 Log likelihood	190.352	209.781	204.313	183.899	200.918	199.312
χ^2	40.986***	21.558***	27.025***	47.439***	30.421***	32.026***

Table 7 continued

Dependent variable	ANYE					
Specification	1	2	3	4	5	6
df	4	4	4	5	5	5
Sig.	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Hosmer and Lemeshow test						
χ^2	10.855*	9.760	4.642	9.186	6.991	10.107
df	6	7	6	8	8	8
Sig.	(0.093)	(0.203)	(0.590)	(0.327)	(0.538)	(0.258)
Pseudo R^2						
Cox & Snell R	0.190	0.105	0.130	0.217	0.145	0.152
Nagelkerke R^2 Square	0.273	0.151	0.187	0.311	0.208	0.218
Percentage correct						
% correct P = 1	34.5	10.9	12.7	45.5	32.7	32.7
% correct P = 0	97.1	96.4	98.6	93.5	94.2	95.0
% overall correct	79.4	72.2	74.2	79.9	76.8	77.3

Regressions were run with binary logit. P values are reported in parentheses. *, **, *** Significance levels of 10, 5, and 1 % respectively

Table 8 Determinants of COD (all countries; N = 194)

Dependent variable	COD								
Specification	1	2	3	4	5	6	7	8	9
Site-specific variables									
CONSTANT	1.301*	1.117	0.774	5.314*	3.292	2.383	0.915	−0.050	−0.830
Sig.	(0.104)	(0.150)	(0.286)	(0.063)	(0.216)	(0.352)	(0.712)	(0.983)	(0.712)
OFFLINE_PRESENCE	0.142	0.241	0.240	0.068	0.281	0.260	0.140	0.243	0.243
Sig.	(0.684)	(0.481)	(0.481)	(0.866)	(0.466)	(0.499)	(0.687)	(0.476)	(0.475)
INTERNAT_CUR	−0.856*			−1.572***			−0.883**		
Sig.	(0.073)			(0.005)			(0.064)		
INTERNAT_LNG		−0.716			−0.876			−0.726	
Sig.		(0.138)			(0.108)			(0.132)	
INTERNAT_DELIV			−0.297			−1.871**			−0.290
Sig.			(0.637)			(0.020)			(0.643)
DELIVERY_RISK				2.172***	2.006***	2.222***			
Sig.				(0.005)	(0.000)	(0.000)			
Sector-specific variables									
TRX_SIZE	−0.125	−0.138	−0.022	−0.504	−0.490	−0.442	−0.121	−0.131	−0.012
Sig.	(0.752)	(0.729)	(0.955)	(0.268)	(0.285)	(0.320)	(0.758)	(0.742)	(0.975)
Country-specific variables									
GDPCAP	0.000	0.000	0.000						
Sig.	(0.703)	(0.430)	(0.309)						
HDI				−9.798**	−6.819*	−6.086	0.743	2.048	2.778
Sig.				(0.022)	(0.088)	(0.124)	(0.831)	(0.534)	(0.395)
Valid observations	194	194	194	194	194	194	194	194	194

Table 8 continued

Dependent variable	COD								
Specification	1	2	3	4	5	6	7	8	9
Model fitting information									
− 2 Log likelihood	210.221	211.238	213.134	168.758	174.081	171.596	210.320	211.473	213.440
χ^2	4.607	3.590	1.694	46.070***	40.747***	43.231***	4.508	3.355	1.387
df	4	4	4	5	5	5	4	4	4
Sig.	(0.330)	(0.464)	0.792	(0.000)	(0.000)	(0.000)	(0.342)	(0.500)	(0.846)
Hosmer and Lemeshow test									
χ^2	7.678	16.323	12.461	9.292	11.653	9.760**	6.073	15.148**	13.257
df	6	6	7	7	7	7	5	6	7
Sig.	(0.263)	(0.012)	(0.086)	(0.232)	(0.113)	(0.203)	(0.299)	(0.019)	(0.066)
Pseudo R^2									
Cox & Snell R	0.023	0.018	0.009	0.211	0.189	0.200	0.023	0.017	0.007
Nagelkerke R^2	0.035	0.027	0.113	0.316	0.283	0.298	0.034	0.026	0.011
Percentage correct									
% correct P = 1	100.0	100.0	100.0	92.5	92.5	92.5	100.0	100.0	100.0
% correct P = 0	0.0	0.0	0.0	48.9	44.7	46.8	0.0	0.0	0.0
% overall correct	75.8	75.8	75.8	82.0	80.9	81.4	75.8	75.8	75.8

Regressions were run with binary logit. P values are reported in parentheses. *, **, *** Significance levels of 10, 5, and 1 % respectively

ANYD is also very diverse, comprising as it does both local and international debit cards, which clearly target a different audience. Here we decided to concentrate on payroll cards (which are popular in Uzbekistan) rather than on Visa Electron and Maestro—purely because we have better data.

In all models below, the dependent variable is the adoption (Y/N) of a given payment instrument by online vendors. Hence, a negative coefficient indicates that the predictor acts as an obstacle, while a positive sign suggests the opposite. Judging from the Cox & Snell and Nagelkerke goodness-of-fit measures, the preferred models fit the data reasonably well. The likelihood ratio (Chi square) statistics and associated *p* values suggest that jointly our explanatory variables have a significant impact.

7.1 Payment risk

In Hypothesis 1, we assumed that e-retailers active in a sector with high transaction amounts are less prone to accept high-risk payment methods. Our results for ANYC in Table 5 show that TRX_SIZE indeed has a negative and highly significant impact on the acceptance of credit cards, which have late finality and are thus high-risk for merchants.[22] Conversely, one would expect TRX_SIZE to have a positive impact on the adoption of instruments that classify as either 'pay in advance' (e-money and debit cards) or 'simultaneous handover' (COD). In Tables 6, 7 and 8 we do find such an impact for payroll cards (D3), but *not* for e-money (ANYE) or COD.

For the latter two, TRX_SIZE is insignificant (and even has the wrong sign).[23] This can, however, be explained. To start with ANYE, e-money schemes by their very nature typically do not target larger-value payments, thus limiting product risk.[24] Turning to COD, the explanation would seem to be a lack of variation: overall, no less than 76 % of our merchants offer this option. The picture that emerges is one where many sites have little choice but to accept paper-based payment instruments—in order not to leave the unbanked in the cold. Another possible explanation is that, as a 'simultaneous' payment instrument, COD occupies a middle position: the payment risk is not put entirely with the buyer, but 'only' shared between buyer and seller.

Finally, the consistent positive impact of TRX_SIZE on the adoption of payroll cards in Table 6 would at first sight seem to confirm H1. There is, however, a

[22] As robustness checks, we repeated the regressions in Table 5 for a sample that progressively excluded Turkmenistan (N = 191), Tajikistan (N = 185), and Kyrgyzstan (N = 162). This was motivated by the observation that, respectively, none, none, and only one of the websites in these countries offer a credit card payment option. Reassuringly, none of the results disappeared and in several cases the significance levels even improved. Moreover, the variant of our TRX_SIZE variable with three rather than two categories also has a negative impact in all models, be it that its significance drops to the 5 % level in models 3 and 9.

[23] The same is true for offline bank transfers (N = 194); results not reported.

[24] The fact that ANYE contains PayPal, which is nowadays more akin to a high-risk credit card than low-risk e-money, could also have been part of the explanation. However, upon reclassifying PayPal as a credit card, the negative sign remained. Incidentally, the reclassification left unchanged—and even improved somewhat—the results for ANYC. Given that there were only 3 sites that accept PayPal but not credit cards the latter is not surprising.

crucial caveat, which also applies to the result for credit cards.[25] The caveat is that there is a competing explanation besides payment risk, namely cost—a variable that we could not control for (see 5.2).

To start with credit cards, it is important to realize that merchant fees for such cards are typically *ad valorem*—that is, a percentage of the transaction value—rather than flat fees per transaction. According to MasterCard, merchant fees for online credit card payments are 1.5–2 % in Kyrgyzstan and around 4 % in Uzbekistan.[26] According to a contact at Kazkommertsbank, merchants in Kazakhstan face a fee of 3.5 % for MasterCard and Visa cards, and 4.5 % for American Express cards. Finally, according to a contact at VneshEconom Bank, fees for Visa credit card payments in Turkmenistan would even be 5 %. Regardless of their precise level, such *ad valorem* fees pose a tremendous problem for our analysis.[27] Indeed, higher values for TRX_SIZE not only increase the payment risk involved (which is what we try to capture), but also raise the credit card fees. In short, the negative sign for TRX_SIZE in Table 5 may be due to risk, cost, or both. Worse, the explanations would seem to be impossible to disentangle because the card fees are *ad valorem* precisely because the risk for the card companies is proportional to the amount paid.

Things are slightly different for (local) debit cards, but again there are interpretation problems. In Table 6, we try to explain the acceptance of so-called payroll cards in Uzbekistan (models 1–6), and Uzbekistan and Kazakhstan combined (models 7–12). According to a contact at Asaka Bank, merchants in Uzbekistan who want to accept the local payroll card only have to buy, lease or rent a POS terminal. There are no monthly or yearly fees for accepting payments, and no per-transaction fees whatsoever.[28] This would seem to solve our interpretation problem. As merchants face no per-transaction costs, the positive impact of TRX_SIZE can apparently only be due to risk: high risk drives merchants to a less risky payment instrument. At first sight, the results in models 7–12, where Kazakhstan is added to the sample, would only seem to strengthen this conclusion. Indeed, according to a contact at Halykbank, merchant fees for the local Altin card, for example, are 1–2 %, depending on the issuing bank. Hence, just as in the case of credit cards, the higher the value of the goods sold, the higher the merchant fee becomes in absolute terms. If costs were the driver, one would thus expect to see a *negative* impact of TRX_SIZE in models 7–12. Hence, apparently the positive impact that we find can only be due to risk.

There is, however, again a caveat, namely that merchants' interest in a payment instrument, ceteris paribus, depends not only on the cost of the instrument itself, but also on that of potential substitutes. Let us take Kazakhstan as an example. Fees for

[25] Also, if TRX_SIZE is replaced by its variant with three categories, it only remains significant (at the 10 % level) in models 9 and 12. In all other models, the positive sign remains, but significance hovers just above 10 %.

[26] Two Uzbek online merchants whom we contacted mentioned 3.5 and 3.6 %, respectively.

[27] The fact that merchants and commercial banks in certain of the countries pointed out that cardholders pay part of these fees—and in some cases apparently even the entire fee—does not solve our problem.

[28] There are no fees for cardholders either. Banks only charge companies 1–2 % for transferring the salaries of employees to their debit cards.

credit and payroll cards are, respectively 3.5–4.5 and 1–2 %. In other words, there is a cost difference of 1.5–3.5 %. As the transaction amount increases, the cost difference becomes larger in absolute terms. Hence, the higher the average value of the goods sold in a sector—the higher the TRX_SIZE—the more attractive it is for a Kazakh merchant to adopt debit cards instead of credit cards. In short, the positive link between TRX_SIZE and the acceptance of payroll cards that we find in models 7–12 of Table 6 might still simply be due to cost—that is, if credit and debit cards really are substitutes.

Fortunately, on closer scrutiny Uzbekistan—which is considered separately in models 1–6—provides us with a specific environment where it *is* possible to draw clear-cut conclusions. For one, as mentioned in Sect. 2, there are hardly any credit cards in circulation, so that credit cards are not much of a substitute for debit cards. Second, and more importantly, from contacts with banks we learned that local businesses are simply not allowed to accept credit cards because such payments involve transactions in USD.[29] Only selected businesses such as hotels, travel agencies and duty-free shops at airports are allowed to accept US dollars and thus credit cards. The 7 Uzbek websites in our dataset that accept credit cards all sell local handicrafts to an international audience.[30] Third, to repeat, Uzbek merchants face no fees for accepting payroll cards. In short, we are presented with a natural experiment of sorts: when transaction size increases the cost of the payment instrument itself does not go up (because there is no variable cost), nor does the cost of what would appear to be the closest substitute (because it is no substitute). Hence, at least in the case of Uzbekistan, the positive impact of TRX_SIZE on the acceptance of debit cards effectively seems to be due to risk. By extension, the negative impact of the same variable on the acceptance of credit cards is probably at least partly due to risk.

One could point out that for Uzbek e-tailers who are not allowed to accept credit cards, the choice is limited to payroll cards, e-money, and COD (or another paper-based instrument)—all instruments for which the payment risk for the seller is relatively low. At first sight, this casts doubts on our claim that the impact of TRX_SIZE on the acceptance of payroll cards is due to risk. However, when an Uzbek consumer uses her payroll card to pay *before* she receives her order the risk rests entirely with her, whereas if she pays COD the payment risk is shared between buyer and seller and the seller also faces agreement risk. In other words, in both cases the payment risk for the seller is low, but not identical, and the overall risk for

[29] Uzbek holders of MasterCard and Visa credit cards need a USD account.

[30] Removal of these 7 sites from models 1–6 in Table 6 does not fundamentally alter the results. In fact, the only change is that none of the variables that try to capture the international orientation of a site (INTERNAT_CUR, etc.) remain significant, but this is only normal. As an aside, given that adopting credit cards is apparently not an option for many Uzbek e-retailers, in an additional robustness check we also re-estimated the regressions for ANYC (in Table 5) without Uzbekistan (N = 158; results not reported). This leaves unchanged our fundamental results; that is, those for TRX_SIZE and DELIVERY_RISK—be it that there are drops in the significance levels. TRX_SIZE is now only significant at the 5 % level (and only at the 10 % level in model 2; that is, the *P* value is 0.051). The significance of DELIVERY_RISK drops to 5 % in model 9, but stays at the 1 % level in models 7–8. This said, the significant results for OFFLINE_PRESENCE disappear completely and those for the INTERNAT variables are severely reduced in number.

the seller is higher with COD—because with COD the buyer might change her mind on the spot (as explained in Sect. 4). Note that in their context examples Liezenberg et al. give cash a '-' for seller risk and debit cards a '++' [34, Table 7, p. 226]—their crucial scoring criterion being "Can the buyer reverse the transaction?" [o.c., Table 2, p. 224].

This said, our claim would seem less convincing in the increasingly common scenario where our Uzbek consumer instead of paying COD pays with her payroll card *on delivery* (via the mobile terminal that the delivery man has brought with him). In this scenario, the timing of both payments is identical and so are all the other situational factors (location, relation, and product). According to the TCM, merchants should thus be indifferent between the two options, and the link between higher TRX_SIZE and higher adoption of payroll cards is puzzling. However, intrinsic features of the instruments matter too. As Arango and Taylor 2, p. 6] point out, "[t]he finality and security of accepting debit cards is rarely an issue for merchants" because sufficient funds are available at the time of sale. And also: "In the case of fraudulent activity, it is usually the card issuer who will absorb the loss, since the authentication relies solely on the technology and has little to do with the merchant." For the specific case of Uzbekistan, the central bank informed us that, lost or stolen cards notwithstanding, there had not yet been any fraud cases with payroll card transactions. Conversely, where cash is concerned, Arango and Taylor [2, p. 6] note that "to receive funds directly exposes the merchant to the risk of theft (internal or external) and counterfeiting, as well as to the risk of human error during the exchange". This difference in risk eludes the TCM,[31] which, in our view, is a shortcoming of the model.

To conclude the discussion of our results for payment risk, let us note that the points of comparison are few and far between. We are only aware of two. Basu and Muylle [5, p. 383] find in a univariate analysis for the US that "Web retailers of high-cost products provide *more* extensive support for online payment" (emphasis added), a category that comprises online credit card payments. Their follow-up study with 2002 data confirms this [42]. Neither study makes mention of a difference in support for offline payment, which suggests that the difference is not significant. Offline payment refers to checks, cash, wire, and offline credit card payments. Basu and Muylle's results would thus seem to clash with ours. However, their findings relate to a different country (the US) and a different period (1999–2002). Second, their 'online payment' category comprises "e-wallets, shopping cart mechanisms, online credit card payments, smart card systems, e-cash, and payment processes through trusted third parties" [5, p. 383]; that is, a very diverse set of instruments, with different risk profiles. (And shopping cart mechanisms are not even a payment instrument.) But then Basu and Muylle's justification for looking into differences between low- and high-cost product industries does not lie with risk, but rather with the extent of consumer involvement (o.c., p. 384).

[31] In their Table 2 with behavioral criteria for scoring context examples Liezenberg note, for *buyer* risk, "Can the buyer reverse the transaction? *How well secured is the solution?*" (emphasis added), but the latter type of risk does not appear explicitly in their model. Also, in the same Table there is no mention of intrinsic security of a payment instrument under the heading seller risk.

The study by Zhang and Li [64] provides a second (partial) point of comparison. Zhang and Li analyze 260 eBay transactions and use probit analysis to explain whether the seller offered a credit card payment option, either via PayPal, via Billpoint (at the time eBay's in-house alternative), or seller-processed. In their results the price of the product sold has a positive sign but is not significant. This could be because eBay is in essence a P2P setting with few 'real' merchants (in Zhang and Li's dataset seller-processed credit card transactions account for only 1.54 % of the total number; see Table 3 on p. 1082). For individual sellers on eBay, PayPal or Billpoint are in fact the only options. The variation in the prices observed by Zhang and Li might also be limited.

7.2 Delivery risk

In H2 we posited that e-retailers who offer delivery methods with a high delivery risk for the seller are less risk-averse overall, and are thus also more likely to adopt high-risk payment methods. The positive and highly significant impact of DELIVERY_RISK on the acceptance of (risky) credit cards in Table 5 is perfectly in line with this hypothesis. Models 4–6 provide more detail: there is a positive link between the use of courier services (risk score = 2) and ANYC. Turning to Table 6, the absence of a significant impact of DELIVERY_RISK on the acceptance of (low-risk) payroll cards is also plausible. Indeed, as pointed out when developing H2, e-retailers who have no problem offering high-risk delivery methods are probably happy to accept low-risk payment methods as well. To further corroborate this, we also ran regressions—not reported here—for the total number of payment options provided, TOTALALL (see Table 3 for a definition). To be clear: the variable TOTALALL is computed on the level of *individual* payment options. This implies that a site that accepts, say, Visa, MasterCard, American Express, Visa Electron, Maestro, WebMoney, as well as COD, gets a value of 7. As an alternative, we also computed a similar variable on the level of *categories* (namely TOTALCAT), implying that the site in our example now gets a 4—as it accepts payment options in the categories C, D, E, and P. In both cases, DELIVERY_RISK has a positive and highly significant impact, indicating that less risk-averse merchants offer more payment options. Although this cannot really be inferred from the regressions, the results convey the image that, on average, less risk-averse merchants, like all others, offer the safer payment options, but *on top of* these also accept a number of more risky instruments.

Note that there is an obvious endogeneity issue here (and in other regressions below that link individual payment and delivery methods). Clearly, the results should not be seen as implying a causal relationship running from delivery to payment methods. It is plausible that e-retailers determine both simultaneously. As a matter of fact, we also ran regressions with the LOGISTICS variables as the dependent variable (not reported) and found broadly similar results.

Turning to ANYE (in Table 7), here the positive impact of DELIVERY_RISK actually surprises, as e-money is prepaid and thus low-risk for the merchant. Perhaps risk-prone merchants are less reluctant to adopt the more innovative

payment instruments.[32] Interestingly, there is a strong positive correlation between ANYE and ANYC (0.482***). Finally, in Table 9 there is again a counterintuitive positive impact of DELIVERY_RISK on a low-risk payment option, namely COD. A large part of the explanation lies in the fact that for Kazakhstan, which accounts for 126 of the 194 observations, there is a significant positive impact of LOGISTICS_POST (risk score = 3)—on COD; results not reported. Use of the postal system and COD seems to be a 'natural' combination in this country. Another part of the explanation lies in the combination, for the full sample, of courier services (risk score = 2) and COD.

7.3 Control variables

In Table 5 it can be seen that the offline penetration of credit cards, as measured by %CARDS_CREDIT_FINDEX, has, in line with expectations, a positive and significant impact on online merchant acceptance in models 1–5, but not in model 6, and that the impact becomes altogether insignificant when DELIVERY_RISK is added.[33] However, for local payroll cards the impact of consumer uptake is undeniable. In Table 6, %CARDS_LOCAL has a positive and highly significant coefficient in all models where it appears.[34] Since the penetration of electronic payment instruments is often linked with the level of economic development, we also experimented with GDP per capita and the Human Development Index for those instruments for which we lacked the necessary data (ANYE) or for which a direct test makes no sense (COD). For e-money this was not particularly successful. For COD, HDI appears with a negative sign in models 4–6 in Table 8, and is significant in two of the three models.

Turning to the site-specific variables, the impact of OFFLINE_PRESENCE is clear-cut: negative for the online instruments (credit cards and e-money), positive for offline payroll cards (albeit somewhat less significant), and none at all for COD.

[32] Just as for TRX_SIZE, in a robustness check we reclassified PayPal under credit cards. However, the only impact was a somewhat lower significance of DELIVERY_RISK.

[33] When %CARDS_CREDIT_FINDEX is replaced by either %CARDS_CREDIT_LITS, %CARDS_INTERNAT, or TRANSACTCAP, the variable only remains significant in the simple models 1–2. But then both %CARDS_INTERNAT and TRANSACTCAP are very rough proxies of the penetration of credit cards. As explained in Sect. 2, in reality not all international cards are credit cards. Conversely, when %CARDS_CREDIT_FINDEX is replaced by %ACCOUNT_FI, the results improve: %ACCOUNT_FI has a positive and significant coefficient in models 1–7, and the significance levels are higher. Notice that %CARDS_CREDIT_FINDEX and %ACCOUNT_FI are strongly correlated (0.975), which is understandable.

[34] When we replaced %CARDS_LOCAL with %CARDS_DEBIT_LITS, the latter proved to be equally significant but—puzzlingly—appeared with a *negative* sign. The same was true for %CARDS_DEBIT_FINDEX. The explanation is that whereas %CARDS_LOCAL focuses on payroll cards, for both %CARDS_DEBIT_LITS and %CARDS_DEBIT_FINDEX a debit card is a debit card. As can be seen in Table 12, the correlation between %CARDS_DEBIT_LITS and %CARDS_DEBIT_FINDEX is near perfect, but the correlation between either of these and %CARDS_LOCAL is low. In other words, they simply do not measure the same phenomenon. The fact that %CARDS_DEBIT_LITS and %CARDS_DEBIT_FINDEX failed to yield results in regressions (not reported) for ANY(D1 + D2)—which measures whether an online vendor accepts Visa Election and/or Maestro cards—confirms that these variables are just not specific enough for our purposes.

The latter makes sense because pure-plays can make use of home delivery services. Finally, our results for the dummies that capture whether merchants want to sell to foreign markets also make sense.[35]

8 Conclusions

In this paper, we have described and analysed the adoption of payment instruments by e-retailers in five Central Asian transition economies. To the best of our knowledge, we are the first to establish such a *status quaestionis*. The grand picture that emerged from our descriptive analysis is as follows. For one, there are wide divergences in the state of the *offline* payments market: the penetration of payment cards differs dramatically across countries, and so does access to financial services. Second, compared to their counterparts in the developed world, e-retailers in the region still rely more on traditional, paper-based payment instruments such as offline bank transfers and COD. Somewhat surprisingly, there did not prove to be a significant (negative) correlation between on the one hand the percentage of banked people or the countries' level of economic advancement (as measured by GDP per capita) and the availability of a COD option on the other. However, from the perspective of the e-retailers, perhaps the *precise* number of people who do not have a bank account does not matter: as long as the number is substantial, a site leaves a substantial number of potential customers in the cold if it does not accept cash. Overall, the situation thus seems to be one where the majority of the sites have little choice but to accept at least one paper-based instrument (in order to cater for the unbanked), but where on top of that quite a few sites in the more advanced countries (Kazakhstan and Uzbekistan) also accept electronic instruments, which is hardly the case in the other three countries.

Where delivery methods are concerned, the most interesting finding is the high number of sites that have set up delivery channels of their own. Although the setting is not fully comparable, it is tempting to refer to China's leading e-commerce company Alibaba's dissatisfaction with the "delays and patchy quality in distribution and delivery" offered by local logistics companies and its decision to build a massive logistics network for its Taobao B2C site [17]. 360buy, the group that runs Jingdong Mall, China's second-largest online retailer, later made a similar push [18].

Turning to our logit analysis, on the theoretical level we can conclude that the model put forward by Liezenberg et al. [34] appears relevant but not faultless. It is relevant because our results confirm that higher payment risk caused by higher transaction amounts increases the probability that online merchants adopt lower-risk instruments such as debit cards. Also in line with the TCM, we find a negative relationship between average transaction size and the adoption of higher-risk credit

[35] The only result that needs some explaining is the negative impact of INTERNAT_CUR on the acceptance of local payroll cards. Indeed, it is not immediately clear why sites with an international orientation would shun what is after all a fairly novel local payment instrument. The explanation lies with the 7 Uzbek websites that sell local handicrafts and are thus not particularly targeting the local market. Once these sites are removed, the impact disappears completely, as already mentioned in footnote 30.

cards. However, here we cannot exclude a competing explanation, in the form of acceptance costs for the merchant. This said, we do find that merchants who offer higher-risk delivery options are also more prone to adopt higher-risk payment instruments, which is an indirect indication that risk plays a role in merchants' choice of payment solutions—including credit cards. At the same time, our results for Uzbek payroll cards reveal that the TCM overlooks the fact that when all situational factors (timeline, location, relation, and product) are identical, there may still be differences in risk between payment instruments, simply because of intrinsic features.

From an empirical angle, our two core hypotheses—on the role of risk—are broadly supported, although evidence for the first is less strong than for the second since it proved impossible to disentangle the impacts of risk and cost, except in the rather unique case of payroll cards in Uzbekistan. Our control variables also yield interesting results. For example, we find that sites that target international markets are more likely to adopt online payment methods but do not necessarily shun (local) offline substitutes, as many probably also want to cater to the domestic market. More importantly, for both credit and (especially) local payroll cards we find evidence that offline penetration positively affects online merchant adoption, in line with the network externalities theory.

In terms of managerial implications, it is interesting to note that at least credit card companies seem well aware of the importance that online merchants attach to payment risk. The 3-D Secure technology—which is marketed as Verified by Visa and SecureCode—is a case in point. 3-D Secure is in fact card companies' second attempt to make online transactions safer. Unlike when they launched Secure Electronic Transactions (SET) in 1996, for 3-D Secure both Visa and MasterCard offered merchants a "chargeback liability shift". This implies that the payment risk, R_P, no longer lies with the merchant, but either with the issuing bank (when the merchant is enrolled in 3-D Secure, but the cardholder is not) or with the cardholder (when both the merchant and the issuing bank are enrolled and the password was entered correctly[36]). According to the TCM, such an incentive should encourage uptake by merchants. Looking ahead, an improved insight into online merchants' attitude towards the different forms of risk should also help in gauging their willingness to adopt (and pay for) novel payment services, such as Klarna, that hinge on an alternative distribution of payment risk between seller and buyer. As Klarna co-founder Sebastian Siemiatkowski points out: "Sending money to an online merchant, hoping to receive a product that resembles what you saw in the picture is actually a risky undertaking for the consumer" [39]. This is why Klarna allows online shoppers to pay via invoice *after* receipt of the goods. This increases risk for the merchant, but Klarna takes on that risk—obviously for a fee. Klarna claims its solution is worth it because it increases conversion; in terms of the TCM: because it lowers agreement risk. The perspectives of digital currencies such as Bitcoin, which have immediate finality, can also be analyzed by means of the TCM. Indeed, besides lower transaction costs compared to credit cards, for merchants part of the attraction of Bitcoin might also lie in the lower payment risk. As Jonathan

[36] When the password is not entered correctly, the transaction is declined.

Johnson, executive vice-chairman of Overstock.com, the US discount online shopping company, puts it: "We are very careful with checking [credit card transactions] and we still lose 0.2 % of our sales to fraud. For other businesses it can be 1 %. But because Bitcoin is like cash, we don't get chargebacks" [48]. Finally, it is interesting to observe that the only novel online payment system that has been launched in Uzbekistan since we collected our data, namely CLICK, is a 'pay in advance' instrument.[37]

To conclude, our study is not without limitations. There is the limited availability and uncertain quality of data on the offline payments market. Also, our proxies for transaction size and merchants' risk aversion are fairly rough. Predictably, our first set of suggestions for further research build on this. For one, we would encourage future researchers to rely less on publicly available data, and—in line with the present paper—try to collect data on the penetration of payment instruments themselves; either by contacting banks and payment providers directly, or by conducting a survey among consumers. Second, a natural extension of our research would be to try to improve the data collection effort on the merchant side and come up with a better way to gauge average transaction size. We also see three wider-ranging avenues for further research. First, it would be interesting to complement our supply-side test of the TCM with a demand-side test. Second, it would be interesting to be able to compare our findings with findings for developed economies (although the lack of variation in the acceptance of cards might pose problems similar to those we experienced for COD). Finally, a longitudinal analysis would be even more interesting, in particular with an eye on finding out whether online merchants in transition economies will follow their counterparts in developed economies in accommodating consumer preferences for cards, or whether transition economies will continue to exhibit idiosyncrasies.

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Appendix

See Tables 9, 10, 11, 12 and 13.

[37] In May 2011 UZKART introduced new SmartVista cards that have, and this is a first, e-commerce capabilities. Consumers can make payments online from a personal account that they have opened with 'Click.uz' and to which they have linked a bank account.

Table 9 Definitions of explanatory variables

Variable codes	Description	Source
Site-specific variables		
OFFLINE_PRESENCE	Dummy variable: bricks & clicks = 1, pure-plays = 0	Own survey
INTERNAT_CUR	Dummy variable: takes 1 when prices are (also) mentioned in foreign currency, 0 otherwise	Own survey
INTERNAT_LNG	Dummy variable: takes 1 when website content is (also) in foreign language, 0 otherwise	Own survey
INTERNAT_DELIV	Dummy variable: takes 1 when the site states explicitly that they deliver internationally, 0 otherwise	Own survey
LOGISTICS_PRIVATE	Dummy variable for delivery type: private delivery 0/1	Own survey
LOGISTICS_COURIER	Dummy variable for delivery type: courier service 0/1	Own survey
LOGISTICS_INSTORE	Dummy variable for delivery type: in-store pick-up 0/1	Own survey
DELIVERY_RISK	Ordinal variable, ranges between 1 and 3. Merchants are assigned a 'risk coefficient' corresponding to the highest-risk delivery method that they use, with in-store pick-up and private delivery low-risk (value = 1), courier services medium-risk (value = 2), and the national postal system high-risk (value = 3)	Own survey
Sector-specific variables		
TRX_SIZE	E-commerce sectors have been categorized according to the average value of the products sold: low (value = 1) vs medium or high (2)	Own survey
Country-specific variables		
%ACCOUNT_BANK	Percentage of households with a bank account, for the year 2010	EBRD [9]
%ACCOUNT_FI	Percentage of individuals aged 15 + with an account at a formal financial institution, for the year 2011	Demirguc-Kunt and Klapper [8]
%CARDS_INTERNAT	Number of payment cards with international brands (Visa, MasterCard, etc.) in circulation divided by total population × 100. There are no such cards in Tajikistan and Turkmenistan, so these countries are excluded from the analysis	Authors' own compilation based on National Banks. See Table 1
%CARDS_LOCAL	Number of local debit cards in circulation divided by total population × 100. Includes only Kazakhstan and Uzbekistan	Authors' own compilation based on National Banks. See Table 1
%CARDS_CREDIT_LITS	Percentage of households with a credit card, for the year 2010	EBRD [9]
%CARDS_DEBIT_LITS	Percentage of households with a debit card, for the year 2010	EBRD [9]

Table 9 continued

Variable codes	Description	Source
%CARDS_CREDIT_FINDEX	Percentage of individuals aged 15 + with a credit card, for the year 2011	Demirguc-Kunt and Klapper [8]
%CARDS_DEBIT_FINDEX	Percentage of individuals aged 15 + with a debit card, for the year 2011	Demirguc-Kunt and Klapper [8]
GDPCAP	Gross Domestic Product per capita, in USD, for the year 2009	World Bank [63]. See Table 1
HDI	Human Development Index, for the year 2009 (range: 0.58–0.71)	UNDP [60]
TRANSACTCAP	Number of transactions with payment cards, per capita	Authors' own compilation based on National Banks. See Table 1

Table 10 Descriptive statistics

	N	Mean	SD	Skewness	
	Statistic	Statistic	Statistic	Statistic	SE
Site-specific variables					
OFFLINE_PRESENCE	194	0.58	0.50	−0.32	0.18
INTERNAT_CUR	194	0.14	0.35	2.10	0.18
INTERNAT_LNG	194	0.12	0.33	2.3	0.18
INTERNAT_DELIV	194	0.07	0.26	3.33	0.18
LOGISTICS_PRIVATE	194	0.19	0.39	1.59	0.18
LOGISTICS_COURIER	194	0.63	0.48	−0.56	0.18
LOGISTICS_INSTORE	194	0.31	0.47	0.81	0.18
DELIVERY_RISK	194	1.81	0.67	0.24	0.18
Sector-specific variables					
TRX_SIZE	194	1.73	0.44	−1.06	0.18
Country-specific variables					
%ACCOUNT_BANK	191	7.26	4.39	−0.70	0.17
%ACCOUNT_FI	194	32.11	14.69	−1.10	0.18
%CARDS_INTERNAT	185	34.61	21.97	−0.79	0.18
%CARDS_LOCAL	162	6.34	9.92	1.35	0.19
%CARDS_CREDIT_LITS	191	4.16	2.43	−0.68	0.18
%CARDS_DEBIT_LITS	191	5.65	2.59	−1.31	0.18
%CARDS_CREDIT_FINDEX	194	6.55	3.40	−0.74	0.18
%CARDS_DEBIT_FINDEX	194	24.14	10.80	−1.33	0.18
GDPCAP	194	4865.77	2759.65	−0.67	0.18
HDI	194	0.68	0.05	−0.74	0.18
TRANSACTCAP	191	5.96	3.91	−0.68	0.18

Table 11 Correlations (N = 194, except indicated otherwise)

	OFFLINE_PRESENCE	INTERNAT_CUR	INTERNAT_LNG	INTERNAT_DELIV	LOGISTICS_PRIVATE	LOGISTICS_COURIER	LOGISTICS_INSTORE	DELIVERY_RISK	TRX_SIZE	%ACCOUNT_BANK (N=191)
OFFLINE_PRESENCE	1									
INTERNAT_CUR	−0.168**	1								
	0.019									
INTERNAT_LNG	−0.027	.120*	1							
	0.707	0.095								
INTERNAT_DELIV	−0.003	.176**	.258***	1						
	0.963	0.014	0							
LOGISTICS_PRIVATE	−0.01	−0.044	0.057	−0.085	1					
	0.894	0.546	0.432	0.24						
LOGISTICS_COURIER	0.021	−0.035	−0.072	.171**	−.557***	1				
	0.767	0.632	0.318	0.017	0					
LOGISTICS_INSTORE	.535***	−0.048	−0.052	−0.06	−0.074	.261***	1			
	0	0.508	0.47	0.405	0.302	0				
DELIVERY_RISK	0.028	−0.044	−0.083	.255***	−.433***	.779***	.187***	1		
	0.701	0.541	0.251	0	0	0	0.009			
TRX_SIZE	0.095	−.194***	−.232***	−0.101	−.151**	.120*	.134*	0.093	1	
	0.189	0.007	0.001	0.161	0.036	0.095	0.062	0.198		
%ACCOUNT_BANK (N=191)	0.01	−.300***	−.135*	0.082	−.170**	.294***	0.045	.405***	0.065	1
	0.887	0	0.063	0.261	0.019	0	0.541	0	0.37	
%ACCOUNT_FI	−0.002	−.281***	−0.118	0.111	−0.099	.228***	0.078	.345***	0.052	.947***
	0.979	0	0.1	0.125	0.171	0.001	0.279	0	0.469	0
%CARDS_INTERNAT (N=185)	0.024	−.282***	−0.118	0.066	−.188**	.302***	0.041	.407***	0.068	.999***
	0.742	0	0.11	0.37	0.01	0	0.578	0	0.358	0
%CARDS_LOCAL (N=162)	−0.073	.359***	.174**	−0.006	.231***	−.330***	0.056	−.397***	−.141*	−1.00***
	0.354	0	0.027	0.941	0.003	0	0.481	0	0.074	0
%CARDS_CREDIT_LiTS (N=191)	0.017	−.307***	−.139*	0.075	−.179**	.302***	0.036	.411***	0.073	.997***
	0.815	0	0.055	0.301	0.013	0	0.624	0	0.313	0
%CARDS_DEBIT_LiTS (N=191)	−0.027	−.227***	−0.092	0.109	−0.106	.225***	0.092	.334***	0.011	.920***
	0.713	0.002	0.207	0.133	0.143	0.002	0.205	0	0.876	0
%CARDS_CREDIT_FINDEX	0.016	−.316***	−.140*	0.096	−.137*	.269***	0.054	.387***	0.078	.995***
	0.824	0	0.052	0.185	0.057	0	0.458	0	0.281	0
%CARDS_DEBIT_FINDEX	−0.012	−.253***	−0.102	0.116	−0.077	.202***	0.091	.316***	0.036	.901***
	0.87	0	0.155	0.106	0.285	0.005	0.207	0	0.616	0
GDPCAP	0.017	−.306***	−.140*	0.08	−.172**	.296***	0.038	.408***	0.075	.999***
	0.819	0	0.051	0.27	0.017	0	0.603	0	0.3	0
HDI	0.006	−.297***	−.136*	0.087	−.160**	.285***	0.047	.398***	0.063	.997***
	0.929	0	0.058	0.23	0.026	0	0.52	0	0.38	0
TRANSACTCAP (N=191)	0.017	−.314***	−.144**	0.075	−.179**	.302***	0.032	.412***	0.076	.997***
	0.811	0	0.047	0.304	0.013	0	0.656	0	0.295	0

Table 11 continued

	%ACCOUNT_FI	%CARDS_INTERNAT (N=185)	%CARDS_LOCAL (N=162)	%CARDS_CREDIT_LITS (N=191)	%CARDS_DEBIT_LITS (N=191)	%CARDS_CREDIT_FINDEX	%CARDS_DEBIT_FINDEX	GDPCAP	HDI	TRANSACTCAP (N=191)
OFFLINE_PRESENCE										
INTERNAT_CUR										
INTERNAT_LNG										
INTERNAT_DELIV										
LOGISTICS_PRIVATE										
LOGISTICS_COURIER										
LOGISTICS_INSTORE										
DELIVERY_RISK										
TRX_SIZE										
%ACCOUNT_BANK (N=191)										
%ACCOUNT_FI	1									
%CARDS_INTERNAT (N=185)	.930***	1								
	0									
%CARDS_LOCAL (N=162)	−1.00***	−1.00***	1							
	0	0								
%CARDS_CREDIT_LITS (N=191)	.921***	1.00***	−1.00***	1						
	0	0	0							
%CARDS_DEBIT_LITS (N=191)	.997***	.896***	−1.00***	.889***	1					
	0	0	0	0						
%CARDS_CREDIT_FINDEX	.975***	.989***	−1.00***	.985***	.954***	1				
	0	0	0	0	0					
%CARDS_DEBIT_FINDEX	.993***	.873***	−1.00***	.868***	.999***	.943***	1			
	0	0	0	0	0	0				
GDPCAP	.909***	1.00***	−1.00***	.999***	.903***	.971***	.859***	1		
	0	0	0	0	0	0	0			
HDI	.930***	.997***	−1.00***	.989***	.938***	.973***	.890***	.994***	1	
	0	0	0	0	0	0	0	0		
TRANSACTCAP (N=191)	.919***	.999***	−1.00***	.999***	.886***	.984***	.865***	.999***	.991***	1
	0	0	0	0	0	0	0	0	0	

Pearson correlation (2 tailed); *, **, *** indicate significance levels of 10, 5, and 1 % respectively

Table 12 Country-level correlations (N = 5, except indicated otherwise)

		%ACCOUNT_BANK	%ACCOUNT_FI	%CARDS_INTERNAT	%CARDS_LOCAL	%CARDS_CREDIT_LITS	%CARDS_DEBIT_LITS	%CARDS_CREDIT_FINDEX	%CARDS_DEBIT_FINDEX	GDPCAP	HDI	TRANSACTCAP
%ACCOUNT_BANK	*r*	1										
	N	4										
%ACCOUNT_FI	*r*	.92*	1									
	Sig.	0.084										
	N	4	5									
%CARDS_INTERNAT	*r*	.997**	0.883	1								
	Sig.	0.048	0.311									
	N	3	3	3								
%CARDS_LOCAL	*r*	−1.00***	−1.00***	−1.00***	1							
	Sig.	.	.	.								
	N	2	2	2	2							
%CARDS_CREDIT_LITS	*r*	.992***	0.86	1.00**	−1.00***	1						
	Sig.	0.008	0.14	0.012								
	N	4	4	3	2	4						
%CARDS_DEBIT_LITS	*r*	0.884	.997***	0.838	−1.00***	0.821	1					
	Sig.	0.116	0.003	0.367		0.179						
	N	4	4	3	2	4	4					
%CARDS_CREDIT_FINDEX	*r*	.990**	.970***	0.979	−1.00***	.965**	.941*	1				
	Sig.	0.01	0.006	0.132		0.035	0.059					
	N	4	5	3	2	4	4	5				
%CARDS_DEBIT_FINDEX	*r*	0.865	.995***	0.81	−1.00***	0.798	.999***	.941**	1			
	Sig.	0.135	0	0.399		0.202	0.001	0.017				
	N	4	5	3	2	4	4	5	5			
GDPCAP	*r*	.998***	0.662	1.00***	−1.00***	.995***	0.861	0.75	0.616	1		
	Sig.	0.002	0.223	0.008		0.005	0.139	0.145	0.268			
	N	4	5	3	2	4	4	5	5	5		
HDI	*r*	.984**	0.647	.993*	−1.00***	.958**	.926*	0.696	0.615	.979***	1	
	Sig.	0.016	0.238	0.075		0.042	0.074	0.192	0.269	0.004		
	N	4	5	3	2	4	4	5	5	5	5	
TRANSACTCAP	*r*	.994***	0.873	.999**	−1.00***	.996***	0.834	.971**	0.811	.999***	.975**	1
	Sig.	0.006	0.127	0.03		0.004	0.166	0.029	0.189	0.001	0.025	
	N	4	4	3	2	4	4	4	4	4	4	4

Pearson correlation (2 tailed); *, **, *** Significance levels of 10, 5, and 1 % respectively

Table 13 List of e-commerce sectors and their classification in terms of transaction size

Low risk	Medium risk	High risk
Books/music/videos	Apparel/accessories	Automotive parts/accessories
Flowers/gifts	Home Furnishings	Computers/electronics
Food/drug	Mass merchant	Hardware/home improvement
Health/beauty	Office supplies	Housewares
	Sporting goods	Jewelry
	Toys/hobbies	Specialty/non-apparel

References

1. Alzola, L. M., & Robaina, V. P. (2010). The impact of pre-sale and post-sale factors on online purchasing satisfaction: A survey. *International Journal of Quality & Reliability Management, 27*(2), 121–137.

2. Arango, C., & Taylor, V. (2008). Merchant acceptance, costs, and perceptions of retail payments: A Canadian survey. Bank of Canada Discussion Paper 2008-12. Last accessed October 3, 2015, from http://www.bankofcanada.ca/wp-content/uploads/2010/01/dp08-12.pdf.
3. Ardizzi, G. (2012). The impact of microchips on payment card fraud. *Journal of Financial Market Infrastructures, 1*(2), 25–44.
4. Avesta Investment Group. (2008, March 10). Обзор Основных Экономических Событий: Оборот по пластиковым картам составил 594 млрд. Сум [A review of essential economic events: Plastic card turnover amounts to 594 bn Soum]. Last accessed October 3, 2015, from http://data.cbonds.info/comments/2008/30406/ud080310r.pdf.
5. Basu, A., & Muylle, S. (2002). Online support for commerce processes by web retailers. *Decision Support Systems, 34*(4), 379–395.
6. Bounie, D., François, A., & Van Hove, L. (2015). Consumer payment preferences, network externalities, and merchant card acceptance: An empirical investigation. Working Paper. Last accessed October 2, 2015, from http://ssrn.com/abstract=2405361.
7. Committee on Payment and Settlement Systems. (2003). *A glossary of terms used in payments and settlement systems*. Bank for International Settlements. Last accessed October 3, 2015, from http://www.bis.org/publ/cpss00b.pdf.
8. Demirgüç-Kunt, A., & Klapper, L. (2012, April). Measuring financial inclusion: The Global Findex Database. World Bank Policy Research Paper 6025.
9. European Bank for Reconstruction and Development (EBRD). (2011, June 29). The life in transition survey II. Last accessed October 3, 2015, from http://www.ebrd.com/news/publications/special-reports/life-in-transition-survey-ii.html.
10. Federal Financial Institutions Examination Council (FFIEC). (2010, February). Retail payment systems. IT Examination Handbook. Last accessed October 3, 2015, from http://ithandbook.ffiec.gov/ITBooklets/FFIEC_ITBooklet_RetailPaymentSystems.pdf.
11. Fries, S., & Taci, A. (2005). Cost efficiency of banks in transition: Evidence from 289 banks in 15 post-communist countries. *Journal of Banking & Finance, 29*(1), 55–81.
12. Gavish, B., & Tucci, C. L. (2006). Fraudulent auctions on the Internet. *Electronic Commerce Research, 6*(2), 127–140.
13. Govers, R., & Go, F. M. (2005). Projected destination image online: Website content analysis of pictures and text. *Information Technology & Tourism, 7*(2), 73–89.
14. Guislain, P. (2004). The postal sector in developing and transition countries: Contributions to a reform agenda. Working Paper. The World Bank Group Global Information and Communication Technologies Department, Policy Division. (September 1, 2004). Last accessed October 3, 2015, from http://go.worldbank.org/ZU787HHW00.
15. Hawk, S. A. (2004). Comparison of B2C E-commerce in developing countries. *Electronic Commerce Research, 4*(3), 181–199.
16. Hayes, A. F., & Krippendorff, K. (2007). Answering the call for a standard reliability measure for coding data. *Communication Methods and Measures, 1*(1), 77–89.
17. Hille, K. (2010, October 20). Alibaba plans China Delivery Network. *Financial Times*. Last accessed October 8, 2015, from http://www.ft.com/intl/cms/s/0/8dbb3baa-dc6d-11df-a0b9-00144feabdc0.html.
18. Hille, K. (2012, June 13). Chinese online retailer eyes acquisitions. *Financial Times*. Last accessed October 3, 2015, from http://www.ft.com/cms/s/0/8e99bf70-b46f-11e1-bb2e-00144feabdc0.html.
19. Hinshaw, D. (2012, June 5). Online Shopping Emerges in Nigeria. *The Wall Street Journal*. Last accessed October 3, 2015, from http://online.wsj.com/article/SB10001424052702303879604577412043390891430.html.
20. Hu, L., Zhang, W., & Xu, Q. (2013). The determinants of online payment method choice: Insight from an eye-tracking study. In *WHICEB 2013 proceedings.* Paper 80.
21. ICT Policy Project. (2008). Review of information and communications technologies development in Uzbekistan for 2006–2008. UNDP. CIAU. Last accessed October 3, 2015, from http://www.undp.uz/en/publications/publication.php?id=212.
22. Innopay. (2009, March). Online payments 2009—European market overview. Last accessed October 3, 2015, from https://innopay.com/blog/online-payments-2009-european-market-overview/.
23. Jonker, N. (2011). Card acceptance and surcharging: The role of costs and competition. *Review of Network Economics, 10*(2), 1–35.
24. Karimov, F., & Brengman, M. (2014). An examination of trust assurances adopted by top Internet retailers: unveiling some critical determinants. *Electronic Commerce Research, 14*(4), 459–496.

25. Katz, M. L., & Shapiro, C. (1985). Network externalities, competition, and compatibility. *American Economic Review, 75*(3), 424–440.
26. Kim, C., Tao, W., Shin, N., & Kim, K.-S. (2010). An empirical study of customers' perceptions of security and trust in e-payment systems. *Electronic Commerce Research and Applications, 9*(1), 84–95.
27. King, D. (2012). Chip-and-PIN: Success and challenges in reducing fraud. Working Paper. Retail Payments Risk Forum, Federal Reserve Bank of Atlanta. Last accessed October 3, 2015, from https://www.frbatlanta.org/documents/rprf/rprf_pubs/120111_wp.pdf.
28. Kosse, A. (2010, June). Creditcards: acceptatie en gebruik van toeslagen door winkeliers. Een pilot onderzoek. Working Paper. De Nederlandsche Bank.
29. Kosse, A. (2013). Do newspaper articles on card fraud affect debit card usage? *Journal of Banking & Finance, 37*(12), 5382–5391.
30. Koyuncu, C., & Bhattacharya, G. (2004). The impacts of quickness, price, payment risk, and delivery issues on on-line shopping. *Journal of Socio-Economics, 33*(2), 241–251.
31. Kshetri, N. (2013). Cybercrime and cyber-security issues associated with China: some economic and institutional considerations. *Electronic Commerce Research, 13*(1), 41–69.
32. Lee, H. L., & Whang, S. (2001). Winning the last mile of e-commerce. *MIT Sloan Management Review, 42*(4), 54–62.
33. Li, H., Ward, R., & Zhang, H. (2003). Risk, convenience, cost and online payment choice: A study of eBay transactions. Working Paper. Georgia Institute of Technology. Last accessed October 3, 2015, from http://www.prism.gatech.edu/~hl45/research/ebay.pdf.
34. Liezenberg, C., Lycklama, D., & Smorenberg, H. (2007). Understanding buyer and seller behaviour for improved payment product development. *Journal of Payments Strategy & Systems, 1*(3), 219–227.
35. Loke, Y. J. (2007). Determinants of merchant participation in credit card payment schemes. *Review of Network Economics, 6*(4), 474–494.
36. Mallat, N., & Tuunainen, V. K. (2008). Exploring merchant adoption of mobile payment systems: An empirical study. *e-Service Journal, 6*(2), 24–57.
37. Mascha, M. F., Miller, C. L., & Janvrin, D. J. (2011). The effect of encryption on internet purchase intent in multiple vendor and product risk settings. *Electronic Commerce Research, 11*(4), 401–419.
38. Mayhew, B. (2007). *Central Asia (Lonely Planet Travel Guides)* (4th ed.). London: Lonely Planet.
39. Milne, R. (2013, March 6). A Swedish take on 'buy now, pay later'. *Financial Times*. Last accessed October 8, 2015, from http://www.ft.com/cms/s/0/35f1d24a-7f6c-11e2-8d96-00144feabdc0.html.
40. Molla, A., & Licker, P. S. (2005). eCommerce adoption in developing countries: A model and instrument. *Information & Management, 42*(6), 877–899.
41. MoneyNews. (2007, February 1). В Узбекистане растут объемы безналичных карточных платежей [The volume of non-cash payments is rising in Uzbekistan]. Last accessed October 7, 2015, from http://moneynews.ru/7786/.
42. Muylle, S., & Basu, A. (2004). Online support for commerce processes and survivability of web retailers. *Decision Support Systems, 38*(1), 101–113.
43. National Bank for Foreign Economic Activity of the Republic of Uzbekistan. (2010). Пластиковые карточки НБУ - для тех, кто ценит время и комфорт! [Plastic cards of NBU—for those who value time and comfort!]. Last accessed October 7, 2015, from http://uzbank.net/plastfiznbu.php.
44. National Bank of Tajikistan. (2010, May). Платежная система Республики Таджикистан [Payment system of Tajikistan]. Last accessed October 7, 2015, from http://nbt.tj/ru/payment_system/.
45. National Bank of the Kyrgyz Republic. (2010, May 27). Отчет о текущем состоянии платежной системы Кыргызской Республики [Report on current payment system of Kyrgyz Republic]. Last accessed October 7, 2015, from http://www.nbkr.kg/index1.jsp?item=97.
46. National Bank of the Republic of Kazakhstan. (2010, November 1). Статистика по платежным карточкам [Statistics regarding plastic cards]. Last accessed October 7, 2015, from http://www.nationalbank.kz.
47. Odedra-Straub, M. (2003). E-commerce and development: Whose development? *Electronic Journal of Information Systems in Developing Countries, 11*(2), 1–5.
48. Palmer, M. (2014, March 26). Bitcoin: Retailers adopt virtual currency. *Financial Times*. Last accessed October 8, 2015, from http://www.ft.com/intl/cms/s/0/90b9c5c0-adb5-11e3-9ddc-00144feab7de.html.

49. Plouffe, C. R., Vandenbosch, M., & Hulland, J. (2001). Intermediating technologies and multi-group adoption: A comparison of consumer and merchant adoption intentions toward a new electronic payment system. *The Journal of Product Innovation Management, 18*(2), 65–81.
50. Plus Journal. (2010, February 28). Карточный рынок Узбекистана: 75:25 в пользу торговых транзакций [Plastic card market of Uzbekistan]. Last accessed October 7, 2015, from http://www.plusworld.ru/daily/kartochniy-rinok-uzbekistana-7525-v-polzu-torgovih-tranzakciy/.
51. Polasik, M., & Fiszeder, P. (2010, February 28). Factors determining the acceptance of payment methods by online shops in Poland. Working Paper. Nicolaus Copernicus University, Torun. Last accessed October 7, 2015, from http://ssrn.com/abstract=1541202.
52. Ramanathan, R. (2010). E-commerce success criteria: Determining which criteria count most. *Electronic Commerce Research, 10*(2), 191–208.
53. Roztocki, N., & Weistroffer, H. R. (2008). Information technology investments in emerging economies. *Information Technology for Development, 14*(1), 1–10.
54. Roztocki, N., & Weistroffer, H.R. (2009). Research trends in information and communications technology in developing, emerging and transition economies. *Roczniki Kolegium Analiz Ekonomicznych Zeszyt (Annals of the Collegium of Economic Analysis)*, 20, 113–128. Last accessed October 7, 2015, from http://ssrn.com/abstract=1577270.
55. Schuh, S., & Stavins, J. (2015). How do speed and security influence consumers' payment behavior? Current Policy Perspectives No. 15-1. Federal Reserve Bank of Boston. Last accessed October 7, 2015, from http://www.bostonfed.org/economic/current-policy-perspectives/index.htm.
56. Singh, M. (2002). E-services and their role in B2C e-commerce. *Managing Service Quality, 12*(6), 434–446.
57. Stavins, J. (2013). Security of retail payments: The new strategic objective, public policy. Discussion Papers No. 13-9. Federal Reserve Bank of Boston. Last accessed October 7, 2015, from http://www.bostonfed.org/economic/ppdp/index.htm.
58. Trend Capital. (2010, July 28). Оборот по пластиковым картам в Узбекистане в первом полугодии вырос в 2,5 раза [Turnover of plastic cards in Uzbekistan has increased 2.5 times in the first half of the year]. Last accessed October 7, 2015, from http://mail2.trend.az/capital/banks/1727341.html.
59. Truman, G. E., Sandoe, K., & Rifkin, T. (2003). An empirical study of smart card technology. *Information & Management, 40*(6), 591–606.
60. UNDP. (2010). The human development index (HDI 2010). Last accessed October 7, 2015, from http://hdr.undp.org/en/content/human-development-report-2010.
61. Van Hove, L. (1999). Electronic money and the network externalities theory: Lessons for real life. *Netnomics, 1*(2), 137–171.
62. Van Hove, L. (2016). Could 'nudges' steer us towards a 'less-cash society'? In J. Gorka (Ed.), *Transforming payment systems in Europe*. Palgrave Studies in Banking and Financial Institutions (Forthcoming).
63. World Bank. (2009). Population 2009. Data Catalog (2010). Last accessed October 7, 2015, from http://data.worldbank.org/data-catalog.
64. Zhang, H., & Li, H. (2006). Factors affecting payment choices in online auctions: A study of eBay traders. *Decision Support Systems, 42*(2), 1076–1088.