

Achieving Authentication in Electronic Markets: A Principal-Agent Perspective

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Abstract

This research attempts to develop a conceptual foundation for authentication in electronic markets by drawing upon the well-known principal-agent theory in Economics. First, principal-agent theory is discussed and related to authentication in electronic markets. Then, the technologies and business functionalities that are currently available to support authentication in electronic markets are evaluated through an agency cost lens. This is then used to develop a decision theoretic framework that assists online sellers in establishing authentication. Finally, the scientific and practical implications of the study are outlined and future avenues for research suggested.

1 Introduction

In recent years the World Wide Web on the Internet has become the poster child of new ways to communicate, conduct research, educate, entertain, shop, and do business. Significant advances in Internet technology, sociological adoption, and business practice are shaping a virtual society and electronic marketplace that is swiftly becoming an integral part of our day-to-day lives. However, the commercial viability of such an electronic marketplace is directly dependent on the extent to which it supports a multi-layered collection of services, ranging from network services, over commerce services, to content services (Basu and Muylle, 1999).

At the level of commerce services, the authentication process takes on a singularly important role in Electronic Commerce (EC). Indeed, as traditional authentication mechanisms

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based on physical inspection are no longer feasible in EC, online markets need to support novel authentication mechanisms that overcome buyers' and sellers' concerns when transacting in online environments (e.g., Jarvenpaa et al., 2000). In this regard, CommerceNet (2000) points to user authentication and trust as one of the most significant barriers to the growth of EC, while the empirical work of Basu and Muylle (2001a) finds remarkably low support for authentication in EC among Web retailers.

Clearly, given the critical importance of authentication in EC, science-based theory and guidelines are needed in this area to assist electronic markets in achieving commercial success. This research attempts to develop a conceptual foundation for authentication in EC by drawing upon the well-known principal-agent theory in Economics. First, principal-agent theory is discussed and related to authentication in EC. Then, the technologies and business functionalities that are currently available to support authentication in EC are evaluated through an agency cost lens. This is then used to develop a decision theoretic framework that assists online sellers in establishing authentication in EC. Finally, based on the theoretical and practical insights gained from the decision-theoretic framework, major directions for future research are outlined.

2 A Principal-Agent Theoretic Perspective on Authentication in EC

Agency theory is concerned with the ubiquitous agency relationship which arises "between two (or more) parties when one, designated as the agent, acts for, on behalf of, or as representative for the other, designated the principal, in a particular domain of decision problems" (Ross, 1973, p.134). Typical examples include the employer-employee, client-lawyer, citizen-state, owner-manager, and buyer-seller relationships (e.g., Ross, 1973; Harris and Raviv, 1978; Pratt and Zeckhauser, 1985). In its simplest form, the agency relationship involves the agent undertaking an action that affects the welfare of the principal, in return for a fee at least as high as the agent's next best alternative. However, if both the principal and the agent are utility maximizers it may well be that the agent does not always act in the principal's best interest. As such, an agency problem can arise due to (a) conflicting goals of the agent and the principal, and (b) the difficulty or high cost for the principal to verify or control the agent's activities. This problem is directly related to the aspects of hidden action and hidden information, which are frequently referred to as moral hazard and adverse selection (Arrow, 1985; Holmström, 1979). Hidden action exists due to a lack of effort (shirking) on the part of the agent that cannot be adequately verified by the principal, whereas hidden information pertains to the agent having information the principal is lacking, which is critical for determining the agent's optimal course of action (Arrow, 1985; Besanko et al., 1996). Furthermore, in addition to this agency problem and its aspects of hidden action and hidden information, there is a potential problem of risk sharing as the principal and the agent may prefer different actions because of their different propensities to accept risk (Shavell, 1979; Grossman and Hart, 1983).

In order for the principal to resolve, or at least mitigate, these two types of problems, the principal can establish appropriate incentive systems that induce the agent to make optimal decisions from the principal's viewpoint, and/or implement control systems designed to limit the self-interested behavior of the agent. In addition, in particular instances, the agent may bear bonding costs to guarantee that he will not engage in behavior that would harm the principal or to ensure that the principal will be compensated if he does undertake aberrant activities. However, even if the above-mentioned means of co-aligning the principal's interests with the agent's behavior are relied upon, most agency relationships will still involve some divergence between the agent's decisions and the decisions that would maximize the principal's welfare. The monetary cost involving the latter is known as the "residual loss," while the sum of the former two costs (control costs incurred by the principal and the bonding costs borne by the agent) and the residual loss is defined as "agency costs" (Jensen and Meckling, 1976).

2.1 An Agent Theoretic Approach to Authentication in EC

Principal-agent theory is well suited to offer unique insight as authentication in EC involves settings where substantial goal conflict between market participants is likely, where problems of hidden action and hidden information may arise, and where there is sufficient outcome uncertainty to trigger the risk implications of the theory (Eisenhardt, 1989). In the situation where a principal (a bona fide online buyer) engages an agent (an online seller) to obtain goods or services that satisfy its needs, the agency problem involves the potential danger that the agent (1) acts as a fly-by-night operator, (2) provides goods and services of inadequate quality; and/or (3) invades the principal's privacy. Therefore, in general, a bona fide seller needs to invest in authentication mechanisms that assist bona fide buyers in evaluating seller identity and quality (in terms of the seller's credibility and quality of his business practices), as well as product identity and quality, and that are sufficient to induce the buyer to engage in an online transaction (Basu and Muylle, 2001a, 2001b). Such a transaction is then governed by an agency contract (Ross, 1973; Jensen and Meckling, 1976; Keeley, 1980; Perrow, 1986; Eisenhardt, 1989) where the buyer pays a fee (the sales price) in return for the seller's products or services.

The mitigation of agency problems concerning authentication in EC involves agency costs. The buyer incurs control/monitoring costs to gather and verify information on the seller and its products, while the seller bears bonding costs to guarantee its identity and quality, as well as the identity and quality of its products. In addition, a residual loss may occur if the buyer refrains from purchasing online because it is not convinced by the bona fide seller's authentication efforts. It is also important to note that both the principal (a bona fide buyer) and the agent (a bona fide seller) may engage one or more other agents (trusted third parties) to support authentication in EC. A comprehensive overview of the various authentication mechanisms that are available in EC (based on Basu and Muylle, 2001b) and their related agency costs is provided in the next section.

2.2 Agency Costs of Authentication in EC

Although the buyer could contact the seller directly (e.g., Web site, e-mail, telephone) to obtain and verify information on the identity and quality of the seller and its products, robustness, i.e. the extent to which the authentication mechanism achieves trust, is bound to be very low in case of a first-time buyer-seller interaction. However, the buyer can still incur these control costs, and subsequently engage another agent (a third party) to verify this information. For instance, the buyer can check this information indirectly with site registration organizations such as Network Solutions, business information services such as Dun & Bradstreet, online directories such as Yahoo! Business Directories, experts such as Consumer Reports, and public sources such as external press releases. Furthermore, the buyer may visit independent virtual communities covering the seller’s industry and query participants about the seller and its products. These authentication mechanisms are summarized in Table 1.

<i>Mechanism</i>	Focus	Cost	Robustness		Inter- mediary
			No Transaction History	Transaction History	
Direct Authentication Mechanisms					
Accessing Seller Directly	Seller Product	Variable	Low	High	None
Indirect Authentication Mechanisms					
Trusted Third Parties	Seller Product	Variable	High	High	Buyer- selected
Independent Virtual Communities	Seller Product	Variable	High	High	Buyer- selected

Table 1. Buyer-Supported Authentication Mechanisms

Clearly, the buyer incurs control costs in adopting these authentication mechanisms, and, in case of indirect mechanisms, robustness is directly dependent on buyer-perceived reliability of the third parties. However, as the buyer self-selects the intermediaries, robustness is generally considered to be high.

It is important to note that the above buyer control costs are variable in nature, i.e., the buyer incurs these costs with every single seller-interaction so that the total cost borne by the buyer increases as the number of interactions increases. In this respect, it should also be noted that, in case of repeat transactions, the need for the buyer to resort to these direct and indirect authentication mechanisms may diminish strongly once the buyer is familiar with and is confident about the seller and its products.

As opposed to letting the buyer incur substantial control costs in collecting and verifying information on the seller and its products, the seller may invest in authentication mechanisms that significantly decrease buyer control costs, while increasing seller bonding costs. Table 2 shows various seller-supported authentication mechanisms currently in use in EC environments.

<i>Mechanism</i>	Focus	Cost	Robustness		Inter- mediary
			No Transaction History	Transaction History	
Direct Authentication Mechanisms					
Web site content originating from Seller	Seller Product	Fixed	Low	High	None
(URL) Advertising	Seller Product	Fixed	High	High	None
Product Try-outs	Product	Fixed	High	High	None
Indirect Authentication Mechanisms					
Digital Certificates issued by Third Party	Seller	Fixed	Low to High	High	Seller-selected
Online Trust Services	Seller	Fixed	Low to High	High	Seller-selected
Virtual Communities hosted by Seller	Seller Product	Fixed	Low	High	Seller-selected
Web site content originating from Public Sources	Seller Product	Fixed	Low to High	High	Seller-selected
<i>Seller Incentives to Buyer</i>					
Incentives to Buyer	Seller Product	Variable	High	High	Seller-selected
Incentives to Buyer	Buyer	Variable	Low	High	None

Table 2. Seller-Supported Authentication Mechanisms

Direct seller-supported authentication mechanisms attempt to authenticate the seller and/or its products without involving a third party. A seller can provide a basic level of support for seller and product authentication by publishing Web site content on itself and its product. As this information may be biased and no public record of the information may exist, a potential buyer most likely perceives robustness to be low in a first-time buyer-seller interaction. However, as already mentioned, this authentication mechanism may become very efficient once transaction history is built. As opposed to Web site content originating from the seller, advertising of seller and product in public media provides non-repudiation and is thus likely to

achieve higher buyer-perceived robustness. However, this higher level of buyer-perceived robustness comes at the price of high advertising costs. Similarly, product try-outs allow the buyer to more reliably assess product identity and quality at a high cost for the seller.

It should be noted that the bonding costs borne by the seller to support these direct authentication mechanisms are fixed in nature, i.e., the seller incurs these costs regardless of the total number of interactions with buyers. Therefore, as the number of buyer-seller interactions increases, the average bonding cost for the seller decreases, resulting in economies of scale in seller and/or product authentication.

Instead of, or beyond supporting direct authentication mechanisms, the seller can invest in indirect authentication mechanisms in which it assumes the role of principal and engages an agent, i.e. a third party, to augment buyer trust in seller and product authentication. For instance, a seller may pay a Certification Authority (CA such as Verisign or Entrust) a fee for providing it with a digital certificate that authenticates its seller identity for a certain period of time. Likewise, with online trust services such as TRUSTe's Online Privacy Seal Program (Benassi, 1999) and WebTrust assurance services provided by the American Institute of Certified Public Accountants (AICPA) and the Canadian Institute of Chartered Accountants (CICA) (Srivastava and Mock, 2000), a bona fide seller conveys information about its identity and quality that is backed up by credible, although paid for, third party assurance for a limited period of time. The bonding costs borne by the seller in supporting the above two authentication mechanisms are fixed in nature and provide room for economies of scale as they can be spread over an increasing number of interactions in the period covered by third party assurance.

Two different types of agency relationships involve the use of virtual communities hosted by the seller, and Web site content originating from public sources. In the first case, existing buyers of the seller's product share their thoughts about the company and its products with prospective buyers. Thus, the seller's current buyers act on its behalf to support seller and product authentication at no cost to the seller. However, the seller still incurs fixed bonding costs for hosting the virtual community. As to Web site content originating from public sources, the principal collects and discloses information bolstering its identity and quality from trusted sources such as external press releases and experts. The principal incurs fixed search and content management costs, while the indirect agents are not paid because of their independent nature.

Clearly, the level of robustness attributed to these indirect authentication mechanisms is directly dependent on buyer-perceived reliability of the third parties involved. If the buyer perceives a third party to be completely reliable then the authentication mechanism achieves full robustness.

A final category of seller-supported authentication mechanisms involves the seller offering incentives to prospective buyers. A seller may give buyers the opportunity to collect and/or verify seller and product authentication information by paying the buyer's subscription or access fee for third party services. For instance, the seller may pay the buyer's subscription fee for the e-ratings service of Consumer Reports where the buyer can check product reviews and ask experts for advice online. Likewise, the seller may pay a buyer to obtain specialized

reports from companies such as Standard & Poor's or Moody's. A somewhat different option for the seller is to give the buyer stock in its company. As such, the seller bolsters its authentication by showing the buyer that it has complied with SEC rulings to issue stock and, at the same time, provides an incentive for the buyer to transact even more as this directly affects the value of its stock. It should be noted that, by incurring the above variable bonding costs for offering incentives, sellers can address the need for authentication one buyer at the time.

A particular case of authentication incentives is the situation in which the seller requires the buyer to authenticate itself before it can deal with the seller. As such, the seller wants to give the buyer the feeling that it becomes part of an exclusive club which stands for quality as it is highly selective about its members. By creating this aura of exclusivity, the seller imposes a fixed authentication cost on the buyer (the buyer needs to authenticate itself if it wants to be part of the club no matter how many transactions it will engage in), while incurring a variable cost to verify every buyer and its quality.

In addition to buyer-supported and seller-supported authentication mechanisms, buyers and sellers can also choose to interact in an online marketplace governed by an independent digital market maker, as indicated in Table 3. The digital market maker not only matches seller supply with buyer demand but also authenticates participants before allowing them to transact. As such, the digital market maker serves as a mutual agent to both the seller and the buyer in authenticating their identities and quality, as well as seller product quality. Furthermore, the market maker may allow participants to remain anonymous in their dealings in order to avoid strategic information leakage (Basu and Muylle, 2001b). Typically, buyers and sellers pay a fixed fee for participating in these online markets to the digital market maker, together with a cut out of every transaction that is concluded through the online marketplace. Therefore, the initial fixed cost for authentication can be spread over an increasing number of interactions during the period covered by the fee, whereas the total variable cost increases as the number of transactions goes up.

<i>Mechanism</i>	Focus	Cost	Robustness		Inter- mediary
			No Transaction History	Transaction History	
Digital Market Maker	Seller Product Buyer	Fixed and Variable	High	High	Buyer- and Seller- selected

Table 3. Seller-and Buyer-Supported Authentication Mechanisms

3 Decision Model of Authentication in EC

The objective for a bona fide seller is to determine the optimal level of seller and product authentication that it should be investing in to achieve online marketplace success. This requires optimizing its allocation of resources among a portfolio of authentication mechanisms that each have their distinct characteristics in terms of focus, agency costs, robustness in relationship to transaction history, and intermediary involvement (see Tables 1 , 2, and 3).

Toward that end, this paper provides a decision matrix, shown in Figure 1, that bona fide sellers in EC environments can use to determine which authentication mechanisms to invest in.

Focus	New Seller	Mature Seller	
		<i>Basic</i>	<i>Customization</i>
Seller Identity Authentication	<ol style="list-style-type: none"> 1. Advertising 2. Online Trust Services 3. Digital Certificates 4. Web site content public sources 	<ol style="list-style-type: none"> 1. Incentives to buyer 2. Virtual communities 	<i>N/A</i>
Seller Quality Authentication	<ol style="list-style-type: none"> 1. Advertising 2. Online Trust Services 3. Web site content public sources 	<ol style="list-style-type: none"> 1. Incentives to buyer 2. Virtual communities 	<i>N/A</i>
Product Identity Authentication	<ol style="list-style-type: none"> 1. Web site content seller 2. Product try-outs 3. Web site content public sources 4. Advertising 	<ol style="list-style-type: none"> 1. Web site content seller 2. Incentives to buyer 3. Virtual communities 	<ol style="list-style-type: none"> 1. Web site content seller 2. Web site content public sources
Product Quality Authentication	<ol style="list-style-type: none"> 1. Web site content seller 2. Product try-outs 3. Web site content public sources 4. Advertising 	<ol style="list-style-type: none"> 1. Web site content seller 2. Incentives to buyer 3. Virtual communities 	<ol style="list-style-type: none"> 1. Web site content seller 2. Web site content public sources

Figure 1. EC Seller and Product Authentication Decision Matrix

3.1 Dimensions of the Decision Matrix

The decision matrix is organized along two dimensions: (1) Authentication Focus and (2) the Strategic Perspective of the seller.

Authentication Focus: Based on a theoretical framework of authentication in EC proposed by Basu and Mylly (2001b), the following four areas of authentication can be distinguished: (1) seller identity; (2) seller quality, (3) product identity, and (4) product quality. Thus, a seller venturing online needs to inform potential buyers on whom they are dealing with (seller identity), its credibility and quality of business practices (seller quality), what it is dealing (product identity), and what the quality is of its market offering (product quality).

Strategic Perspective: The decision as to which authentication mechanisms to support is a priori influenced by the Strategic Perspective of the seller. As the seller ventures online, defined as a *New Seller* in Figure 1, its goal is to maximize the number of transactions to build a critical mass of customers. Given the absence of any transaction history and the need to induce potential buyers to interact with the seller, the new seller's objective is to build a portfolio of authentication mechanisms that maximizes robustness (given the prospective buyer's typically low propensity to accept risk), minimizes control cost to the buyer, and covers every area of seller and product authentication.

Once the seller's customer base has achieved critical mass, the seller's goal is to redesign its portfolio of authentication mechanisms to maximize profits by exploiting the benefits that result from reputational effects and the building of track records. In doing so, the seller relies on authentication mechanisms that provide sufficient robustness to existing buyers while minimizing bonding cost to the seller. Such a seller is defined as a *Mature Seller*. Furthermore, a distinction can be made between a mature seller pursuing a *basic authentication strategy* versus a mature seller opting for a *customization authentication strategy*. Whereas the former limits its authentication strategy to the mere exploitation of transaction history, the latter enhances the basic strategy by leveraging transaction history and customizing the authentication experience for buyers. Even though such a customization strategy involves extra investments, it allows the seller to build switching costs and lock-in customers, contributing strongly to customer lifetime value (Jarvenpaa et al., 2000; Doney and Cannon, 1997; Ganesan, 1994; Jackson, 1985).

Not only can a rationale for distinguishing between *New* and *Mature Sellers* be found in the widely accepted distinction between a discrete transaction and a relational exchange in marketing theory (Dwyer et al., 1987; Morgan and Hunt, 1994) and practice (Dertouzos et al., 1989), as well as in research on organizational trust (Chiles and McMackin, 1996; Milgrom and Roberts, 1982; Ring and Van de Ven, 1992), but also in agency theory. Indeed, an important moderating variable in agency theory is the type of relationship (Arrow, 1985). Multiple-period agency relationships can be distinguished from short-term agency relationships. Due to their repeated nature, multi-period agency relationships between principals and agents provide opportunities for learning (e.g., Lambert, 1983) and the building of reputation (e.g., Jensen and Meckling, 1976) so that the information on which the fee schedule is based can be largely enriched (e.g., experience rating in insurance (Arrow, 1985)).

Conversely, the single decision analysis in the context of one-time transactions is more likely to offer less room to reduce potential agency costs (Eisenhardt, 1989).

Clearly, the establishment of trust is a strategic priority for a new seller to build a critical mass of customers. Furthermore, as trust attenuates buyer-perceived risk of opportunism, mature sellers can economize on bonding costs so that the overall level of agency costs can be significantly reduced for established buyers. This is illustrated in Figure 2, in which agency costs (sum of seller bonding and buyer control costs) are related to strategic perspective. Figure 2 also shows that *new* buyer control costs may exceed seller bonding costs since a mature seller may not support new buyers in authenticating seller and product identity and quality because of its focus on its installed customer base.

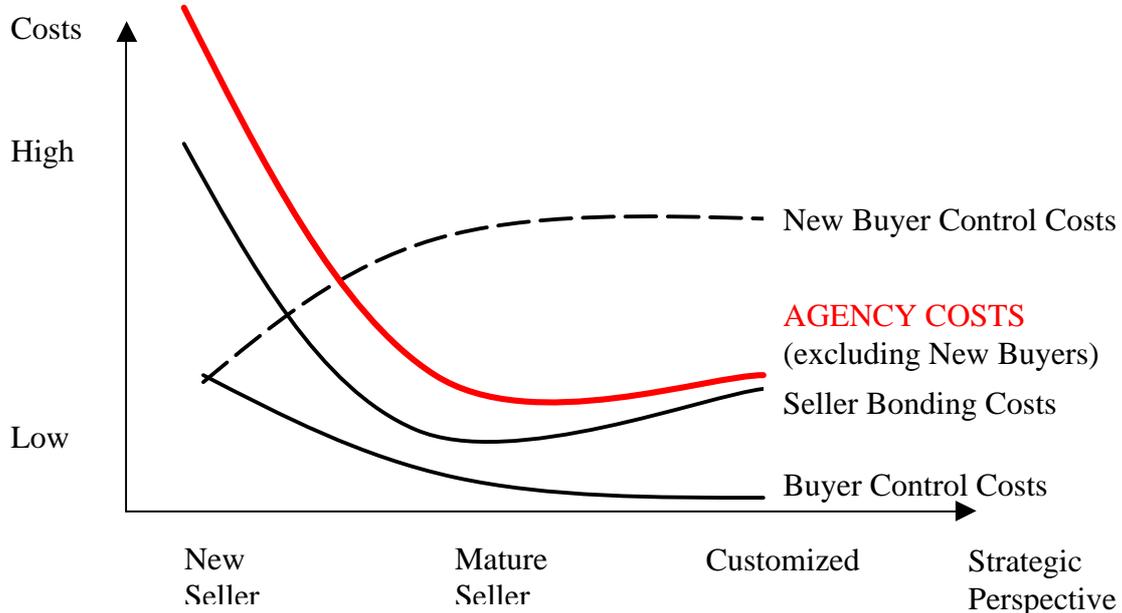


Figure 2. Agency Costs in Authentication in EC

3.2 Decision Matrix Dynamics

At the cell-level, the decision matrix shown in Figure 1 assists bona fide sellers in selecting appropriate mechanisms that cover a particular area of authentication in a particular strategic mode. However, as these mechanisms may span several areas of authentication, and given that sellers need to provide a sufficient level of support for each of the areas, a hierarchy

of authentication support can be discerned for each strategic perspective¹. Hence, at the column-level, a layered approach is proposed that highlights the basic authentication portfolio (indicated by “1”), while complementary mechanisms are suggested that enhance the basic configuration. The latter are listed as a function of their diminishing returns on investment in authentication (indicated by “2”, “3”, or “4”). It is important to note that a seller’s investment in authentication mechanisms should be capped by customer lifetime value as the seller needs to avoid incurring substantial bonding costs to build revenue without any profit potential in the long run (e.g., Blattberg and Deighton, 1996; Hoffman and Novak, 2000). Thus, as shown in the decision matrix, a *conditio sine qua non* for a new seller is to invest in advertising to establish its identity and quality and build traffic to its Web site, as well as invest in its own Web site content to support product identity and product quality authentication.

In order to illustrate the dynamics of the decision framework, the case of a *mature seller pursuing a basic authentication strategy* is discussed. Such a seller can largely rely on reputational effects and buyer learning established during previous transactions. As such, there is no need for supporting authentication mechanisms that assure the *seller’s identity and quality* to its customer base. Furthermore, given that the mature seller’s strategic focus concerns its established customer base, no investments are required in high cost authentication mechanisms such as advertising and online trust services for attracting new customers. In this respect, the mature seller can leave it up to prospective buyers to bear control costs by accessing the seller directly, or by consulting trusted third parties and independent virtual communities (see Table 1 and Figure 2). It should be noted that, in order for the prospective buyer to transact, the control cost it incurs needs to be capped by the value it derives from the product minus the sales price. However, in order to accommodate prospective buyers, a mature seller can offer incentives to facilitate authentication and lower buyer control costs (see Table 2). As the cost for supporting these incentives is variable in nature they constitute a flexible mechanism for supporting seller identity and quality authentication to prospective buyers. In addition to offering incentives, the seller can leverage its own customer base by hosting a virtual community in which prospective buyers can learn first-hand about seller identity and quality from existing customers. Even though the bonding costs borne by the seller for supporting this mechanism are fixed, hosting a virtual community also benefits existing buyers (e.g., they can share product-in-use information, or jointly discuss and solve problems related to installing, using, or disposing of products). This allows the fixed costs not only to be spread over the total amount of interactions between prospective buyers and existing buyers, but also over the interactions among existing buyers.

In terms of product authentication, a mature seller pursuing a basic authentication strategy merely needs to publish Web site content to support *product identity and product quality authentication*. Indeed, as existing customers are already highly familiar with the seller’s product, the need for extensive product authentication support fades away so that no further

¹ It should be noted that the digital market maker mechanism (see Table 3) was not included in the decision matrix since it represents a situation in which an intermediary, the digital market maker, governs seller, product, and buyer authentication. However, sellers participating in such an online marketplace can still use the decision matrix to enhance their authentication strategy, particularly in the domain of product authentication.

investments in product authentication are required, and the seller can enjoy economies of scale as it spreads its fixed content management costs of providing information on its products in its Web site over all buyer-seller interactions. Moreover, this Web site content can also be used to support overall product authentication for prospective buyers. Indeed, in analogy with support for product authentication provided by new sellers, mature sellers can exploit achieved levels of robustness of seller authentication to reduce their level of investment in product authentication by fully relying on Web site content. If necessary, robustness of product authentication for prospective buyers can be enhanced through offering incentives, and hosting virtual communities. As discussed previously, by hosting a virtual community a mature seller can also allow existing customers to assist one another in authenticating the seller's products.

4 Directions for Future Research

A major avenue for further research concerns the empirical validation of the decision framework proposed in this research. For instance, a field study in which the authentication portfolios of companies in diverse strategic modes are studied could identify particular categories of authentication technology and process that most need further refinement and reinforcement. Also, the theory developed in this research would benefit from an investigation of potential interaction effects. Of particular interest would be a study of the effects of brand equity and offline trust on designing authentication portfolios for brick-and-mortar companies venturing online.

In addition to seller and product authentication, buyer authentication assumes an important role in EC environments (Basu and Muylle, 2001b). However, although buyer authentication is of critical importance in the business-to-consumer segment of EC, relatively straightforward authentication mechanisms are available to sellers (e.g., buyer registration at the seller's Web site), and some payment mechanisms (e.g., online credit card transactions) inherently support buyer authentication. On the other hand, in the business-to-business segment of EC, the issue of buyer authentication is relatively more important given the need for peer-to-peer authentication support, and the fact that the seller may transact with competing buyers. Therefore, an important avenue for future research concerns the development of a decision-theoretic model that guides companies in the business-to-business segment of EC in determining the optimal level of support for buyer authentication.

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