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## Suppliers as liquidity insurers

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# Discussion Papers

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## Suppliers as Liquidity Insurers

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## Suppliers as Liquidity Insurers

### Abstract

We examine how financial constraints in portfolios of suppliers affect cash holdings at the level of the customer. Utilizing a data set of private and public French companies and their suppliers, we show that customers rely on their financially unconstrained suppliers to provide them with backup liquidity, and that they stockpile approximately 10% less cash than customers with constrained suppliers. This effect persisted during the global financial crisis, highlighting that suppliers may be viable insurers of liquidity even when financing from banks and other external channels is unavailable. We further show that customers with unconstrained suppliers also simultaneously receive more trade credit; that the reduction in cash holdings is greater for firms with stronger ties to their unconstrained suppliers; and that customers reduce their cash holdings following a significant relaxation in their suppliers' financial constraints through an IPO. Taken together, the results provide important nuance regarding the implications of supplier portfolios and financial constraints on firm liquidity management.

*Keywords: supply chain, cash, credit constraints, liquidity insurance*

*JEL Classification: D92, G20, G30*

## **1. Introduction**

Cash is a critical component of firm liquidity. Besides financing day-to-day operations, cash serves as a buffer against having to access costly external capital markets, and it protects the firm from future financial constraints when such access is unavailable. For financially unconstrained firms—i.e., firms facing small external financing frictions—the availability of liquidity is insured through relatively unrestricted access to financing vehicles such as banks and external capital markets. The advantage for these firms is that they can easily raise capital through stock offerings and debt issuances, or by drawing on lines of credit when the need arises. Internal cash management is therefore not as central a concern for the unconstrained firm, insofar as financial security and future investment are concerned.

In contrast, constrained firms facing greater financing frictions can neither tap into external debt or equity markets, nor can they access capital through banks as easily as unconstrained firms. As these two channels of liquidity are unavailable, financially constrained firms must self-insure and rely on internal funds (such as cash) to a greater extent. Accordingly, constrained firms expecting difficulties and seeking to protect future investment needs respond to these difficulties by building up their cash stockpiles (Almeida et al. 2004). Yet, hoarding cash is costly. Holding costs arise due to a lower rate of return, and stockpiling cash further prevents these firms from diverting funds to other valuable, productive projects. Cash management is thus a salient issue for firms facing financial constraints.

If liquidity is so important for constrained firms, yet at the same time external channels of funding are restricted and holding cash internally is costly, how can financially constrained firms manage their liquidity needs? One viable strategy advocated in the extant literature concerns exploiting customer-supplier relationships. Prior research on interfirm liquidity management has shown that suppliers can alleviate the financing needs of customers by offering backup liquidity in the form of trade credit (Schwartz 1974, Petersen and Rajan 1997) and by absorbing payment defaults (Boissay and Gropp 2013). One incentive for suppliers to do so resides in the fact that it is expensive for customers and suppliers to substitute each other. Whereby substituting suppliers is costly for customers, the nature of the relationship also ensures that the loss of a customer is similarly costly for suppliers (Cuñat 2007). First and foremost, the loss of a customer may directly result in lost revenue. Indirectly, the loss of a customer to bankruptcy, for example, has been shown to adversely impact suppliers by increasing the overall cost of bank lending (Houston et al. 2016), negatively affecting stock performance (Hertzel et al. 2008), and significantly altering profitability and competition between firms (Yang et al. 2015). Recognizing these negative externalities, suppliers may insure their customers if they are faced with adverse shocks (Cuñat 2007, Wilner 2000).

Clearly suppliers that are more creditworthy and have greater access to external capital markets are better suited to provide this type of insurance (Petersen and Rajan 1997). Recent research has shown that the amount of trade credit offered to customers is directly related to suppliers' access to bank credit (Shenoy

and Williams 2017). Suppliers are also more likely to provide backup liquidity to their customers when they themselves do not face financing constraints: as Boissay and Gropp (2013) show, chains of payment default are perpetuated when a customer defaults on their constrained supplier, and this chain stops only at suppliers with “deep pockets.” Therefore, for firms without access to liquidity from banks and external capital markets, suppliers with such access may be a viable and alternative channel of liquidity. Stockpiling cash should then become unnecessary, as customers have access to this alternative source of financing coming from unconstrained suppliers. Financially constrained customers with unconstrained suppliers may be able to reduce their cash holdings, as liquidity is insured through their suppliers’ access to external liquidity.

This line of reasoning hints at one important determinant of corporate cash holdings: the composition of a portfolio of suppliers. In this paper, we focus on the implications that this alternative channel of financing—external liquidity from unconstrained suppliers—has for cash holdings at the level of the customer. We hypothesize that customers with unconstrained suppliers hold less cash than customers with constrained suppliers. Figure 1 tracks the average annual cash holdings of customers in our data set with either financially constrained or unconstrained suppliers (captured by whether or not suppliers are listed on a financial exchange). Throughout the time period covered by our data set, customers with unconstrained suppliers systematically hold a smaller proportion of cash to assets than customers with constrained suppliers. This supports our intuition that customers hold less cash on their balance sheets when their suppliers have access to external financing.

- - - Figure 1 about here - - -

In order to formally test this hypothesis, we employ a detailed data set from the Banque de France comprising over 50,000 public and private French firms and their supplier linkages. We supplement this data set with balance sheet data from the Amadeus database. In order to demonstrate the robustness of our results with respect to the measurement of financial constraint, and because no single, straightforward characterization of financial constraint exists, we categorize customers and their suppliers as financially unconstrained or constrained using three different measures. These are based on whether firms are public or private (Brav 2009, Giannetti 2003, Campello et al. 2010); larger and older or smaller and younger (Hadlock and Pierce 2010); and have low or high levels of intangible assets (Giannetti 2003).

One of the key challenges in studying portfolios of suppliers is that suppliers are not randomly assigned to customers; hence, inferences are vulnerable to concerns regarding self-selection, and econometric techniques that do not attend to this issue may lead to biased results and incorrect conclusions. Therefore, our approach explicitly addresses self-selection concerns. We implement nearest-neighbor matching

(Abadie and Imbens 2011, Abadie et al. 2004) estimators to match customers on observable characteristics. This ensures that customers with constrained or unconstrained suppliers are similar in observables and differ only in their suppliers.

The results from our baseline tests strongly agree with our hypothesis. In our base specification, customers with at least one financially unconstrained supplier hold 10.6% less cash than similar customers with constrained suppliers. The results suggest that supplier financial characteristics play an important role for the cash holdings of the firm: constrained customers rely on their unconstrained suppliers for liquidity insurance, thereby allowing them to free up cash from their balance sheets. As a counterfactual robustness test, we then deconstruct our full sample into constrained and unconstrained customers and examine whether reductions in cash holdings due to unconstrained suppliers are similar for the two groups. We find that constrained customers hold less cash when at least one of the suppliers in their portfolio is unconstrained. On the other hand, as financially unconstrained customers have superior access to external liquidity channels, we anticipate these firms not to differ between constrained or unconstrained suppliers in regard to cash holdings. As expected, unconstrained customers with unconstrained suppliers generally show no disposition towards lower cash holdings.

As our sample covers the time period from 2002 to 2010, we are also able to examine this effect during the 2008 financial crisis and provide new insights regarding the role of suppliers in times of a dramatic increase in financial constraints (Almeida et al. 2011, Ivashina and Scharfstein 2010). Our tests reveal that the backup channel of financing coming from unconstrained suppliers remains open during times of systemic economic downturn. As access to liquidity was particularly important during the crisis (Duchin et al. 2010), we complement research showing that although banks were unable to provide necessary liquidity during a crisis (Acharya and Mora 2015), financially strong suppliers may have been able to do so (Garcia-Appendini and Montoriol-Garriga 2013).

In further robustness checks, we provide evidence corroborating the idea that liquidity insurance from suppliers helped drive reductions in customer cash holdings. First, as a more direct test of liquidity provision, we supplement our data with information on customers' trade payables. We find that customers with unconstrained suppliers concurrently received more trade credit and held less cash than customers with constrained suppliers. Second, we classify suppliers according to the nature of the goods they produce: standardized goods, differentiated goods, or services (Giannetti et al. 2011, Rauch 1999). Research has shown that the transaction of highly specific goods forces suppliers to help their customers when their relationship is at stake (Cuñat 2007). We find that regardless of the transacted good, customers with an unconstrained supplier generally hold less cash. However, the reductions in cash holdings are both more pronounced and more consistently statistically significant for customers with access to financially unconstrained suppliers of differentiated goods and services—exactly those firms with the strongest

supplier links and which would suffer most from disruptions in the supply chain. Third, we employ a sample of supplier initial public offerings (IPOs) to determine whether a supplier going public has an effect on customer cash holdings. As firms become known to the market and gain direct access to equity capital, IPOs can be considered as substantial relaxations in financial constraint. We find that the exogenous shock of an IPO on the financial constraints of a supplier portfolio is associated with a significantly greater reduction in customer cash holdings, compared to the cash holdings of a customer whose portfolio of suppliers remained private. Thus, as suppliers gain direct access to external channels of financing, customers accordingly adjust their cash holdings downwards.

Our paper contributes to the literature in several ways. First, we extend the general stream of research examining corporate cash holdings by showing that the composition of a portfolio of suppliers (with respect to financial constraint) impacts a firm's level of cash holdings. There is a rich body of studies that has attempted to uncover the determinants of firm cash holdings (e.g., Opler et al. 1999, Dittmar et al. 2003, Foley et al. 2007), focusing on transaction, precautionary, tax, and agency motives of cash holdings (see Bates et al. 2009 for a review). A natural extension to this literature has been research examining the substitutability between internal liquidity and external financing vehicles such as lines of credit (Sufi 2009, Lins et al. 2010, Acharya et al. 2013). Yet, an overarching feature of most papers studying cash holdings is that they focus on primarily large, unconstrained firms. Most likely owing to the difficult nature in obtaining data, far fewer studies (e.g., Brav 2009, Saunders and Steffen 2011, Lins et al. 2010) have specifically looked at cash holdings in private firms.

Our paper also complements a related strand of literature on trade credit and inter-firm liquidity insurance and provision. The majority of prior research in this stream has examined the drivers of trade credit (Schwartz 1974, Petersen and Rajan 1997, Burkart and Ellingsen 2004, Cuñat 2007). However, the implications of inter-firm liquidity (or lack thereof) on corporate performance and capital structure have been less studied. Only recently have researchers begun exploring the effects of trade credit extensions on factors such as profitability and investment (Murfin and Njoroge 2015), probability of default (Barrot 2015), and other performance variables such as return on sales and net profit margin (Garcia-Appendini & Montoriol-Garriga 2013). Furthermore, the notion that the composition of the firm's supplier portfolio and the amount of trade credit received and extended can specifically affect corporate structure and liquidity management has largely remained unexplored. One notable exception is Wu et al. (2012), who analyze the sensitivity of a firm's cash holdings to the amount of trade credit the firm extends and receives. They show that firms do not equally value trade payables and receivables, and that they adjust their cash levels accordingly. Although close in subject-matter to our current paper, we deviate from Wu et al. (2012) by explicitly looking at the effects of supplier-level characteristics on cash holdings. Because our data set captures customer-supplier linkages, we are able to examine the nature of portfolios of suppliers. We



further this stream of literature by exploring the consequences of inter-firm liquidity provision and supplier constraints on general corporate liquidity management.

Finally, our paper also adds nuance to the literature on financial constraints measurement. To date, a large body of research (Kaplan and Zingales 1997, Lamont et al. 2001, Whited and Wu 2006, Hadlock and Pierce 2010) has focused on measuring financial constraint using various firm characteristics such as leverage, age, size, and credit rating. Largely, the proposed measures capture the degree of difficulty each firm faces in securing direct channels of external financing. More recent research has suggested examining off-balance sheet policies such as borrowing diversity (Tengulov 2015) to characterize financial constraint. Following in these footsteps, the findings in our paper ultimately suggest that although firms may not be able to directly tap sources of external liquidity, they may actually be able to do so indirectly via their suppliers. Hence, firms which would otherwise be classified as financially constrained could possibly be considered unconstrained if external capital is insured through financially unconstrained suppliers.

## **2. Sample Construction**

Our sample comes from the combination of two separate data sets: an extract of the Banque de France CIPE (“Fichier Central des Incidents de Paiement sur Effets”) data set, and the Amadeus financial database of public and private firms around the world. The CIPE data set contains the unique identification number (SIREN) of public and private French firms which defaulted at least once to their suppliers between 1998 and 2004. This provides us with a unique advantage. In addition to specifying an identifier number for each of these customer firms, it informs of up to 10 of each firms’ top suppliers. The CIPE identifier therefore allows us to build supply chain network linkages among French companies, both publicly listed and private.

We supplement this data set with financial information from the Bureau van Dijk Amadeus database. The Amadeus database contains information on the financials for millions of public and private companies internationally. The advantage of this database is that it allows us to link private firms in the CIPE to their financials. Our analysis is confined to French companies operating from 2002 through 2010: the last nine years of data available when we collected the data.

To clean our sample, we remove financial firms and all firms with any suppliers in financial industries. Further, for most tests we remove customer firms if they are missing information on total assets and cash in any year, so that we are only left with firms with complete information over the sample period. We then average the data to one single cross section for each customer, because we are not concerned with how cash holdings and other firm characteristics change over time or over the business cycle. Rather we are interested in the structural consequences for cash management coming from having an unconstrained supplier.

Our final, baseline dataset for the years 2002 to 2010 consists of 34,005 unique firms. For these firms, we can identify 108,877 suppliers, of which 21,469 are unique suppliers. In later tests where we exclude the crisis and focus on pre-crisis years from 2002 to 2006, our data set consists of 57,940 unique firms with complete balance sheet information, and we can identify 185,734 suppliers, of which 27,680 suppliers are unique. Descriptive statistics for the customers in our data set are provided in Table 1.

- - - Table 1 about here - - -

One point of note is that because our data set captures a portion of French companies which defaulted on their suppliers, it may be the case that it is subject to selection issues and is not representative of the typical French firm. We assess the extent of this issue by comparing the firms in our baseline sample to the entirety of French firms in the Amadeus universe. In comparison to the Amadeus universe (219,309 firms with information on total assets), we find that firms in our baseline sample are quite similar in size (€8.7m mean; €1.7m median total assets in our sample vs. €8.3m mean; €1.4m median in the Amadeus universe). Firms in our sample also hold a slightly smaller ratio of cash to total assets (0.182 mean; 0.124 median vs. 0.196 mean; 0.125 median) and are similarly profitable (0.066 mean; 0.057 median vs. 0.069 mean; 0.055 median EBIT over total assets). Furthermore, public companies compose 0.60% of our sample and 0.43% of the Amadeus database. Our sample therefore seems comparable to the universe of firms in the French economy.

### **3. Variable Definitions**

The focal point of our analysis is the customer. Our main variable of interest is therefore the level of cash held by a customer. Cash holdings of firms have previously been measured in several ways, with the most widely utilized measure being cash scaled by total assets (*Cash Over Total Assets*). However, since in such a measure cash is represented both in the numerator and denominator, Opler et al. (1999) deviate from this and instead use cash holdings scaled by total assets net of cash (*Cash Over Assets Net of Cash*). For consistency and robustness, we report all results for both measures.

Our objective is to uncover the effect of the presence of financially unconstrained suppliers in a customer's supplier portfolio on the customer's cash holdings. Since there is not one straightforward measure of financial constraint, we assess whether firms are constrained or unconstrained with three distinct variables. In our baseline analyses, we capture financial constraint based on the listing status (public or private) of firms (Brav 2009, Campello et al. 2010, Giannetti 2003). In further corroborating tests, we demonstrate the robustness of our results by capturing constraint based on measures of a firm's size-age index (Hadlock and Pierce 2010) and its level of intangible assets (Giannetti 2003). Further complicating

our analysis is the fact that firms may select their suppliers, leading to concerns of self-selection bias. We address this concern by implementing matching estimators (explained in the following section), which considers firms as falling into two categories: financially constrained or financially unconstrained. Therefore, to test whether having an unconstrained supplier affects balance sheet liquidity, each of our treatment variables is coded as a 0 for “constrained suppliers” (the control group) and a 1 for “unconstrained suppliers” (the treatment group). In tests where we distinguish between constrained and unconstrained customers as well, we follow the same methodology for customers.

**Listing Status (*Listed*).** Since our data set covers both private and public firms, we are able to capture whether or not a firm is (or ever has been) listed on an exchange in France. The intuition here is that firms listed on an exchange should be better known by analysts and the market and, more importantly, have direct and easy access to equity capital markets (Brav 2009, Giannetti 2003). Furthermore, firms which are listed tend to be larger and older than private firms. For listed companies, it follows that raising capital should be easier and less costly than for unlisted firms.

To capture a firm’s listing status, we first identify each firm’s International Securities Identification Number (ISIN). In Amadeus, this number is reported as a) a 12-digit alphanumeric code if the firm is currently listed on an exchange, b) “Unlisted” if the firm has never been listed on an exchange, or c) “Delisted” if the firm was at one point listed and then delisted from an exchange. Our binary measure conservatively considers a customer as having unconstrained suppliers if at least one of its suppliers has ever been listed on a stock exchange. Simply stated, if any of a customer’s suppliers is or was listed, we classify this customer as having suppliers with relatively easy access to financial markets. Oppositely, we classify a customer as having constrained suppliers if all of its suppliers have never been listed on a stock exchange.

We observe little variation in customer-supplier relationships over time with respect to constraint: customers and suppliers that are financially constrained tend to stay constrained, and vice versa. Of all the customers in our final sample with available information, only 49 customer firms transitioned from unlisted to listed during this time period. Similarly, only 185 customers had suppliers which went public. In Section 6.3, we exploit supplier IPOs as an instrument for a substantial relaxation in financial constraints.

**Size-Age Index (*SA Index*).** Recent research has proposed measuring firm financial constraints through firm size and age (Hadlock and Pierce 2010). The argument is that smaller and younger firms are generally less well-known, and are therefore more vulnerable to capital market imperfections. Therefore, to proxy for financial constraints based on size and age, we follow Hadlock and Pierce (2010) and compute a size-age index for each firm. Our variable,  $\overline{SA\ Index}$ , is the average of the firm’s annual SA indices. Specifically, we calculate

$$SA\ Index_{i,y} = -0.737(Size_{i,y}) + 0.043(Size_{i,y})^2 - 0.040(Age_{i,y}) \quad (1)$$

$$\overline{SA\ Index}_{i,y} = \frac{\sum_{y=1}^t SA\ Index_{i,y}}{t} \quad (2)$$

where  $i$  denotes each firm,  $y$  denotes a given year within the period of  $t$  total years,  $Size$  is the log of the 2004 inflation adjusted book value of assets (capped at €4.5 billion), and  $Age$  is the number of years since incorporation (capped at 37 years).

In order to employ matching estimators, we categorize firms as financially constrained or unconstrained by following the methodology outlined in Almeida et al. (2004). We first rank firms based on the  $\overline{SA\ Index}$  and then split the distribution into terciles—suppliers in the tercile with the lowest  $\overline{SA\ Index}$  values are considered unconstrained, and those firms in the highest tercile are considered constrained. We consider a customer as having unconstrained suppliers if it has at least one supplier in the unconstrained tercile; a customer has constrained suppliers if all of its suppliers are in the constrained tercile. Firms in the middle tercile are not considered in the analysis.

**Intangible Assets (*Intangibles*).** The third measure captures the intangible assets of a firm. Unlike tangible assets, intangible assets tend to be highly specialized and specific to firms only in limited industries or contexts. Such assets have low re-deployability (Williamson 1998) and tend to have uncertain or lower valuations (Schleifer and Vishny 1992). For firms which rely on intangible assets, it is much more difficult to pledge these assets as collateral. Giannetti (2003) shows that in countries with poor institutional creditor protection (citing France as an example), firms which invest in intangible assets have generally less access to credit. Our third measure of financial constraint thus considers a firm's ratio of intangible-to-total assets: firms with a low ratio of intangibles should be less financially constrained compared to those with higher intangible asset ratios.

To create a measure of constraint based on intangible assets, we follow a procedure similar to our size-age index variable above. We rank firms according to their ratio of intangible-to-total assets. We then split this sample into terciles, with firms with the highest ratios of intangibles-to-assets as being the most constrained. To construct our treatment variable, we consider customers with at least one supplier in the unconstrained tercile to have unconstrained suppliers; customers with all suppliers in the constrained tercile are considered to have constrained suppliers.

One concern regarding the previous measures of financial constraint is that they are likely to be correlated with strength. A bargaining argument could therefore be made that large, old, and public suppliers which are not financially constrained may have more influence over their customers. Stronger suppliers could exert their power onto customers through, for instance, stricter or shorter payment terms.

Yet, in this case, we would expect those customers of malevolent suppliers with greater bargaining power to hold even more cash. As they cannot credibly depend on their suppliers for liquidity, customers would be forced to stockpile even more cash in order to prevent against future liquidity shortfalls. The effect of the bargaining argument would therefore be in the direction opposite to our hypothesized liquidity insurance mechanism.

#### **4. Empirical Results**

We wish to test how having an unconstrained supplier affects customer cash holdings. We specifically argue that customers with financially unconstrained suppliers hold less cash than customers with constrained suppliers. The empirical investigation of this hypothesis, however, is complicated by the fact that customers select their suppliers. Since suppliers are not randomly assigned to customers, this generates self-selection bias in the estimation whereby some confounding variable may directly and simultaneously affect both a firm's supplier selection decision and its cash holdings. Hence, there may be systematic differences in firms which affect their choice of financially unconstrained suppliers, thereby confounding the effect of supplier constraint on cash holdings. To account for this, we implement nearest-neighbor matching (NNM) techniques.

##### **4.1. Econometric Specification**

Matching techniques reduce bias from confounding variables by matching subjects on important characteristics, except for their assignment to a treatment group. In the present context, this means we match customers on covariates in our database which predict whether or not a customer will select financially unconstrained suppliers or not. Such an approach allows us to achieve a sample of customers that are as "similar" as possible, with the difference being whether the customer's portfolio of suppliers is financially constrained or unconstrained. In order to test our hypothesis and simultaneously mitigate concerns of self-selection bias, we implement NNM estimators with replacement. We specify bias-corrected, heteroscedasticity-consistent matching estimators, and we require matching on a minimum of four nearest neighbors, which has been shown in simulations to perform well in terms of mean-squared error (Abadie and Imbens 2011, Abadie et al. 2004).<sup>1</sup> A similar estimation approach has been used to examine the effect of debt maturity on investment around the crisis period Almeida et al. (2011).

Following Caliendo and Kopeinig (2008), we match firms on covariates which fulfill two conditions: they i) simultaneously influence participation in the treatment and the outcome, and ii) are exogenous to and unaffected by participation in the treatment. We thus match on covariates in our data set which could

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<sup>1</sup> Although other matching techniques such as propensity-score matching (PSM) exist, we opt for NNM estimators which allow us to explicitly match on categorical variables. This allows us to remove all confounding coming industry and geographical region.

affect both a customer's selection of unconstrained suppliers and cash holdings, but which are exogenous with respect to the financial constraint of suppliers. Since, to our knowledge, there is no research predicting whether or not customers select financially constrained or unconstrained suppliers, we match customers on variables which are available in our data set, plausibly affect the supplier selection decision, and fulfill the two criteria above.

We match on the natural logarithm of average total assets of the customer over the time period (*Customer Size*) and the natural logarithm of the age of the customer in 2010 (*Customer Age*), both winsorized at the top and bottom 1% levels. Additionally, several studies also show that geographic proximity to analysts and investors plays a significant role in reducing information asymmetries (Loughran and Schultz 2005, Malloy 2005). As being in or near Paris (the financial capital of France and one of the financial centers of Europe) may afford access to different types of suppliers, affect visibility to analysts and investors, and influence a host of firm characteristics, we match customers on a variable indicating whether or not they are in the Île-de-France (Paris) region in France.<sup>2</sup> Finally, we match customers on their industry.<sup>3</sup> Table 2 presents the definitions and sources for the treatment variables and matching covariates we use in our estimations.

In order to test whether indeed customers with constrained or unconstrained suppliers are systematically different from each other in size, age, location, and industry (i.e., whether these factors may confound supplier selection), we specify logit regression models (not shown). For each of our specifications of supplier constraint, the models unequivocally show that larger and older customers tend to select financially unconstrained suppliers. We also find that firms in the Paris region are significantly more likely to transact with financially constrained suppliers. Finally, the industry controls also suggest an association between customer industry and supplier constraint. We find that customers in industries such as construction, commerce, and information and communication tend to select unconstrained suppliers. We conclude that customers with and without unconstrained suppliers are fundamentally different on important characteristics, facilitating empirical analysis with matching methods.

In order to demonstrate that the matching procedure successfully eliminated differences between treated and control customer, we test the efficacy of the matching algorithms by examining the differences in means between groups pre- and post-matching implementation. The results are shown in Table 3, and are broken down according to our three measure of financial constraints. Since we explicitly match customers on categorical variables, all customers are, by definition, matched to other customers in the same exact industry

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<sup>2</sup> The Institut National de la Statistique et des Études Économique (INSEE) divides France into 18 regions. The Île-de-France region surrounds Paris and is the richest region by GDP per capita by a significant margin.

<sup>3</sup> In France, the INSEE categorizes firms into 21 industries. The level of grouping of these sections is comparable to that of the 20 NAICS Sectors in the US.

and whether or not they are in the Paris region. We therefore turn our attention to our continuous matching covariates (*Customer Size* and *Customer Age*). In all cases, the matching algorithms substantially reduce the differences in covariates. Although post-matching differences are statistically significant, this is misleading as the large number of customers in our data set deflates the standard errors considerably. Therefore, we focus on the magnitude of the reduction in differences. For example, examining *Customer Size* for the *Listed* treatment, we find that the matching algorithm has reduced the differences in total assets by more than 95%, from €1.2 million pre-matching to €55,000 post-matching. This post-matching difference is economically small, considering that the average firm in our sample has over €8.0 million in total assets between 2002 and 2010. Similar reductions for the other model specifications and treatment characterizations suggest that the matching algorithms substantially reduce confounding bias from our covariates.

- - - Table 3 about here - - -

#### **4.2. The Effect of Supplier Constraint on Customer Cash Holdings**

Below, we present the results from our baseline matching tests. Our argument is that firms with restricted access to bank credit or other external debt and equity channels stockpile cash in anticipation of future hardships. If, however, one of their suppliers is financially unconstrained and indeed has access to external liquidity channels, then the customer will not have to hoard as much cash and can rely on its supplier to provide emergency liquidity if necessary. In our tests, we expect a customer with at least one unconstrained supplier to hold less cash than a customer with constrained suppliers.

Our baseline models are for the sample from 2002 to 2010. The results of the treatment models are shown in Table 4, where the left panel depicts results for the dependent variable *Cash over Total Assets*, and the right panel depicts results for *Cash over Assets Net of Cash*. The average treatment effect on the treated (ATET) is the average difference in cash holdings between those customers with unconstrained suppliers minus those customers with constrained suppliers. A negative ATET therefore corresponds to lower cash holdings for customers with unconstrained suppliers.

- - - Table 4 about here - - -

We find strong evidence in support of our hypothesis: for each measure of financial constraint, the ATET is negative and all of the models are statistically significant the 1 percent level. All of the models suggest that having an unconstrained supplier is associated with significantly lower cash holdings. Moreover, the magnitude of this effect does not vary considerably from model to model. Regarding *Cash*

over *Total Assets*, the magnitude of the effect of having an unconstrained supplier is equivalent to a decrease between 5.2% (treatment = *SA Index*; ATET = -0.009) and 7.0% (treatments = *Intangibles*; ATET = -0.012) of cash over total assets for the average firm. At the average, these correspond to an overall cash reduction between approximately €71,220 (10.6%) and €95,870 (14.3%), respectively. Similarly, regarding *Cash over Assets Net of Cash*, the effects correspond to cash holding reductions between 5.3% (treatments = *SA Index*; ATET = -0.014) and 9.2% (treatment = *Listed*; ATET = -0.024) of cash over net assets. In summary, we find that having a financially unconstrained supplier corresponds to a statistically and economically significant reduction in cash holdings.

#### **4.3. Customer Constraint, Supplier Constraint, and Cash Holdings**

As an extension to the analysis above, we also wish to examine whether all firms respond to having an unconstrained supplier in a similar manner. In their analysis of corporate cash savings policies, Almeida et al. (2004) propose that, for financially unconstrained firms, having ample cash on hand is redundant. As these firms have easy and relatively unrestricted access to external sources of financing, they are not concerned with stockpiling cash. On the other hand, financially constrained companies are the ones principally concerned with combating future cash shortfalls. If it is indeed the case that the reduction in cash holdings comes from liquidity insurance by unconstrained suppliers, then we would expect only constrained customers to rely on their unconstrained suppliers as sources of backup liquidity. We anticipate that the effect of lower cash holdings due to unconstrained suppliers applies primarily to customers that are themselves financially constrained. Figure 2 displays this intuition.

- - - Figure 2 about here - - -

To examine this counterfactual, we test additional matching estimators after splitting the data set into samples of financially constrained and financially unconstrained customers. Our methodology for classifying customers as constrained or unconstrained is analogous to that outlined in Section 2 for the suppliers. The results are shown in Table 5, where Panel A corresponds to constrained customers and Panel B corresponds to unconstrained customers.

- - - Table 5 about here - - -

In Panel A, the results agree with our baseline results from Table 4. We find that financially constrained customers with unconstrained suppliers hold less cash than constrained customers with constrained suppliers. For each of our measures of financial constraints, all models are statistically significant, and effect sizes are comparable in magnitude to those from the full sample. As expected, for financially



constrained firms, liquidity management is highly relevant, and customers with unconstrained suppliers tend to adjust their cash holdings downwards.

The analyses concerning unconstrained customers only (Panel B), however, fail to show a consistent relationship between supplier constraint and cash. As expected, in the majority of the tests, the models showed no statistically significant differences in cash holdings between unconstrained customers with constrained or unconstrained suppliers. However, although the models measuring intangible assets are statistically significant, this may be driven by the fact that customers which are categorized as unconstrained (low levels of intangibles) are on average around €2.5m in total assets smaller than all other firms in our data set. In essence, even though customers in this group are unconstrained with respect to intangibles, they may be considered constrained with respect to size, and having an unconstrained supplier may still be valuable to some extent for these firms. We further examine this in Appendix A1 by splitting the unconstrained-intangibles group and considering only the largest firms. In line with our conjecture, the most unconstrained customers (largest in assets and lowest in intangibles) are not concerned about their suppliers' constraints and show no proclivity towards lower cash holdings.

In general, and as Almeida et al. (2004) suggest, the results here support the proposition that liquidity reserves management is a salient issue only for constrained firms. Financially constrained customers with unconstrained suppliers tend to adjust their cash holdings downwards. For the sample of financially unconstrained customers, whether or not supplier constraint has an effect on cash holdings is doubtful at best, and having an unconstrained supplier seems to be less relevant for firms with relatively unrestricted access to external liquidity sources.

## **5. What about the Financial Crisis?**

As our data set covers French firms between 2002 and 2010, we can consider two aspects concerning the global financial crisis. First, although the financial crisis systemically affected most firms and industries, it may be the case that certain firms or industries were hit harder than others and so the results we obtain above are an idiosyncratic consequence of the financial crisis. Therefore, as a robustness test, we split our sample and run our models with all years from 2007 and onwards removed.

Second, we wish to examine the value of having an unconstrained supplier specifically during times of crisis. Acharya and Mora (2015) show that during the financial crisis, US banks failed to provide backup liquidity until the government intervened in 2008. They conclude that banks were not adequate liquidity providers during the crisis. Boissay and Gropp (2013) and Garcia-Appendini and Montoriol-Garriga (2013), on the other hand, find that suppliers willingly provide their customers with liquidity insurance in time of need. We complement this research and analyze whether credit constrained firms can, in such cases, rely on their financially stronger suppliers for liquidity.

### 5.1. The Pre-Crisis Period

To examine the first scenario above and rule out whether the recession period negatively biases our results, we confine our sample and focus on those firms having complete data from 2002-2006. Although we are restricting the data set to a shorter time window, the number of firms in our sample increases as it is more likely to have complete information for firms over this shorter window. We recalculate all variables and cutoffs for the treatments, and re-run our matching models. Table 6 shows the results of these tests. Once more, each of the models corroborates our hypothesis that customers with financially unconstrained suppliers tend to hold less cash than those with constrained suppliers. For *Cash over Total Assets*, for example, this effect is equivalent to a reduction between 4.2% (treatment = *SA Index*; ATET = -0.007) and 5.9% (treatment = *Listed*; ATET = -0.014) of cash over total assets. The findings suggest that the cash-reducing effect of unconstrained suppliers is observed in non-crisis times, and is not merely a side-effect of the financial crisis.

- - - Table 6 about here - - -

### 5.2. Supplier Constraint and Cash Holdings During the Crisis

We now turn to the crisis period. As in other developed countries around the world, the financial recession at the outset of the 21<sup>st</sup> century significantly and negatively impacted the French economy. As shown in Figure 3, both GDP and investment dramatically fell between 2008 and 2009. The massive drawdown of inventories during this crisis period also fueled a massive contraction of international trade in France (de Rougemont 2011).

- - - Figure 3 about here - - -

At a more granular level, the crisis also had profound consequences on the availability of financing. Acharya and Mora (2015) show that a reduction in bank deposit inflows led to the failure of the U.S. banking industry to provide backup liquidity to the market. In other words, cash-strapped firms and individuals could not credibly rely on banks to deliver emergency liquidity and alleviate financing concerns. Only after the U.S. federal government stepped in and explicitly backed the banking system were banks able to honor their credit commitments. Ivashina and Scharfstein (2010) further show that while firms with existing lines of credit increased how much they drew down, the number of new loans extended by banks significantly decreased. Examining the German banking sector, Puri et al. (2011) similarly find that banks rejected substantially more loan applications during the crisis than during the pre-crisis period. Moreover,

this finding was especially strong for smaller, more constrained firms. Firms which therefore depended on bank loans in this period were especially affected by the crisis than other firms.

As echoed by the abovementioned studies, the reliability of banks to provide liquidity in times of systemic crisis is questionable. This is particularly true for constrained firms and firms requiring emergency funding the most. If bank financing is unavailable when it is required the most, are suppliers counted upon to act as lenders of last resort? We re-run our matching analyses on the restricted sample for 2008 and 2009, and depict the results in Table 7. The results provide strong support to the notion that suppliers may be adequate providers of backup liquidity during times of crisis. For both of our measures of cash holdings, all models are statistically significant, suggesting that during the crisis, customers with unconstrained suppliers tended to hold less cash.

- - - Table 7 about here - - -

## **6. Further Corroboratory Evidence**

In the previous sections, we show that customer firms hold less cash when their supplier portfolio includes unconstrained suppliers. Yet, in order to paint a more complete picture, and to provide more direct evidence that reduced cash holdings arise due to an alleviation of constraints, we examine three further aspects. First, we supplement our data set with information on customer trade payables and test whether customers with unconstrained suppliers receive more trade credit. Second, we examine whether the nature of goods transacted (differentiated and service versus standardized, see below) between the counterparties plays a role in the relationship between supplier constraint and customer cash. Third, we exploit supplier IPO events and test whether customers adjust cash holdings following a significant relaxation in supplier constraints.

### **6.1. Cash Holdings, Liquidity Provision, and Trade Credit**

If the documented reductions in customer cash holdings are indeed due to an open channel of liquidity on the part of financially unconstrained suppliers, we would then expect an alleviation of constraints to be visible through, for example, an increase in trade credit extended from unconstrained suppliers to their constrained customers. Echoing this intuition, Shenoy and Williams (2017) find that suppliers which themselves have greater access to bank credit are able to offer greater amounts of trade credit to their customers. In this subsection, we offer a more direct test of supplier liquidity insurance by observing the level of trade credit customers receive.

Examining trade credit levels affords us two advantages. First, it allows us to better explain whether suppliers do insure the liquidity of their constrained customers. If suppliers indeed act as liquidity channels of last resort, we expect to see that customers with unconstrained suppliers concurrently hold less cash and

receive more trade credit. Second, it allows us to further address concerns that reductions in cash holdings are merely due to stronger suppliers squeezing their weaker customers. Yet as discussed previously, if this were the case, we would expect constrained customers to hold more cash, thus *ex ante* biasing any results against our hypothesis. As all external channels of obtaining liquidity would be restricted, customers would further rely on their own cash holdings, thus necessitating even greater cash hoarding. Regardless, examining trade credit allows us to directly test if this is the case. If stronger, unconstrained suppliers are constricting their weaker, constrained customers, the former would extend less or shorter terms on trade credit. On the other hand, greater trade credit levels for customers with unconstrained suppliers would support the hypothesis of suppliers as liquidity insurers.

From the Amadeus database, we are able to match information on trade payables to 30,379 customers (89.3%) in our sample from 2006 to 2010.<sup>4</sup> We construct the variable *Trade Payables*<sup>5</sup> for each customer. This is the total amount of trade credit extended to each customer by its suppliers. We scale this variable by total assets and winsorize at 1%.

- - - Table 8 about here - - -

We present our results in Table 8. We find positive and statistically significant effect sizes on trade payables of customers with unconstrained suppliers. Customers with financially unconstrained suppliers tend to have more trade credit extended to them. This is in line with the above reasoning and prior research (Petersen and Rajan 1997, Boissay and Gropp 2013) noting that financially unconstrained suppliers tend to be the financiers of firms and alleviate financial constraints of their customers. In line with our main hypothesis, we once more find (not shown) that during this period, customers with unconstrained suppliers held less cash than customers with constrained suppliers. Together, the results point to the idea that constrained customers lean on their unconstrained suppliers: customers with unconstrained suppliers in their portfolios contemporaneously hold less cash and receive greater trade credit extensions than customers with constrained suppliers.

## **6.2. The Nature of the Transacted Good**

It has been suggested that interfirm liquidity provision is directly related to the closeness of the relationship between the supplier and customer (Cuña 2007, Giannetti et al. 2011). Transacting specialized inputs means that suppliers and customers are difficult to replace, and differentiated goods and services are also unlikely to be diverted by the customer for unintended purposes. In line with this reasoning, Giannetti et

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<sup>4</sup> Due to license restrictions with the Amadeus database, we are only able to retrieve specific information on accounts payable back through 2006.

<sup>5</sup> In the Amadeus database for French companies, this variable is denoted as Supplier Debts and Related Accounts.

al. (2011) find that suppliers tend to finance those customers transacting highly specific intermediate products and services.

This stronger link ensures that customers are especially costly to replace, and vice versa. Within the context of our study, we expect financially unconstrained suppliers to provide liquidity insurance primarily for those constrained customers purchasing differentiated goods and services, and customers of differentiated goods and services should be most likely capitalize on this access to external liquidity through lower cash holdings. Any reductions in cash should be greater for customers when the product being transacted is a differentiated good or a service, as these customers credibly expect a greater alleviation of constraints from their suppliers.

To test this proposition, we classify suppliers in our data set as suppliers of standardized goods, differentiated goods, or services according to Giannetti et al. (2011). This classification is based on whether outputs of firms at the industry level are standardized goods, differentiated goods, or services. Concretely, in our data set, we first match each supplier's industry to one from the classification provided in the Appendix in Gianetti et al. (2011). Then, we create three indicator variables for each supplier (standardized, differentiated, service) and code each variable as 1 if the supplier falls in the category, 0 otherwise. The three variables are mutually exclusive, and thus each supplier can fall into a maximum of one category.

We then place customers into two treatment groups: customers whose unconstrained suppliers provide differentiated goods or services, and customers whose unconstrained suppliers supply standardized goods. We once more specify NNM estimators for these groups of customers, matching customers in each group to a similar customer with constrained suppliers. The results of these models for our baseline time period (2002 to 2010) are depicted in Table 9, with Panel A concerning *Cash over Total Assets* and Panel B concerning *Cash over Assets Net of Cash*. In both panels, the estimates on the left-hand side correspond to the difference in cash holdings between customers with constrained suppliers and customers with unconstrained suppliers of differentiated goods and services. Estimates on the right-hand side correspond to the difference in cash holdings between customers with constrained suppliers and customers with at least one unconstrained supplier of standardized goods.

- - - Table 9 about here - - -

Overall, the results mirror the main argument of our paper, namely that customers with unconstrained suppliers hold less cash than customers with constrained suppliers. Moreover, this effect does not seem to be restricted to customers transacting either differentiated goods and services or standardized goods. In the specifications on the left half of Table 9 (customers with unconstrained suppliers of differentiated goods and services), all of the models are statistically significant. However, the results regarding customers with

suppliers of standardized goods are somewhat mixed: several model specifications on the right half (customers with unconstrained suppliers of standardized goods) are not statistically significant. Furthermore, we find evidence that the effect is economically larger for customers with unconstrained suppliers of differentiated goods and services. When comparing the models by row, in all cases where both specifications are significant, the magnitude of the effect is greater for the customers of differentiated goods and services. Taken together, the analyses here show that although customers in general hold less cash when at least one of their suppliers is financially unconstrained, those customers with stronger ties to their suppliers may be more privy to their suppliers' access to external capital markets. Customers transacting with suppliers of specialized goods and services tend to adjust cash holdings further downwards: as the bond with their suppliers is especially costly to break, external liquidity through an unconstrained supplier is more credibly insured.

### **6.3. Supplier IPO Events**

An IPO event can be considered a significant relaxation in financial constraint. As firms become better known to the market and gain direct access to equity capital, their ability to tap into external pools of liquidity increases dramatically. Importantly, the decision of a supplier to go public is essentially an exogenous shock to the level of financial constraint of a customer's supplier portfolio. As customers cannot control if and when their suppliers go public, such a measure is an excellent candidate to test whether supplier financial constraint indeed affects customer cash holdings. We therefore explore whether the change in listing status of a supplier affects customer cash levels.

We begin our analysis by first identifying the year, if at all, each supplier in our data set underwent an IPO. From the Amadeus database, we are able to identify 185 customers with suppliers that went from private to public during the time period 2002 to 2010. These customers form the "treated" category in our analysis. We then match each treated customer to four "control" customers which did not have a supplier undergo an IPO. We specify that customers be matched on the natural logarithm of total assets and age, and that they be exactly matched on industry section, on whether or not they are in the Paris region of France, and on year in order to control for time effects. For each treated and control customer, we calculate the difference in cash holdings between the following and current year. Summary statistics regarding the two groups are presented in Table 10. As expected, we find evidence that treated customers on average reduced their cash holdings in the year following an IPO event by their suppliers. On the contrary, the average, matched control customer increases its year-on-year cash holdings in the absence of any suppliers going public.

- - - Table 10 about here - - -

In Table 11, we display the results from our statistical tests. Since we are estimating the difference in the change in cash holdings between treated and control customers, the ATET we report is the matched difference-in-difference estimator. For both measures of cash holdings, we find that customers which had a supplier undergo an IPO adjusted their cash holdings significantly further downwards than customers whose suppliers remained private. Following a supplier IPO event, customers respond to the relaxation in financial constraints in their supplier portfolio by reducing their cash holdings to a greater degree relative to other, similar customer firms.

- - - Table 11 about here - - -

## **7. Conclusion**

Do suppliers serve as liquidity insurers for their customers, and if yes, under which conditions? In this paper, we show that the composition of a customer's portfolio of suppliers has important implications for its liquidity management. Specifically, we find that financially constrained customers with at least one unconstrained supplier hold significantly less cash than customers with constrained suppliers. This finding suggests that when other external channels of financing (such as banks and equity and debt markets) are unavailable or inaccessible, liquidity may be insured through financially unconstrained suppliers with access to external capital markets. The existence of this emergency liquidity channel means that constrained firms do not have to stockpile as much cash to protect against future cash shortfalls.

Our empirical design involves using a novel data set of private and public French firms matched to their top suppliers. Since suppliers are not randomly assigned to customers, we explicitly address concerns of self-selection bias by implementing nearest-neighbor matching estimators. When compared to customers with financially constrained suppliers, we find that similar customers with unconstrained suppliers systematically hold about 10 percent less cash on average. Further tests show that this lower level of cash is accompanied by a concurrent increase in the customer's trade payables; that cash reductions are greater for customers with stronger links to their unconstrained suppliers; and that customers adjust their cash holdings downwards following an IPO by one of their suppliers. These findings lend support to the notion that reductions in customer cash holdings are due to an alleviation of constraints, arising from their suppliers' superior access to external financing channels. We also explore the implications of supplier constraint during times of crisis and find that this effect seems to persist even through times of systemic liquidity shock. This result echoes prior research suggesting that even in situations when banks are unwilling or unable to ensure access to liquidity, financially strong suppliers may still be counted upon to do so.

We believe that these results make contributions to the literature on cash holdings, customer-supplier relationships, and the characterization of financial constraints. Our paper shows that by affecting cash holdings, supplier portfolios and relationships play a significant part in informing a firm's liquidity management policy. The insurance of access to external liquidity through upstream partners may therefore indicate that customers with unconstrained suppliers are in fact less constrained than similar customers with constrained suppliers. More broadly, our paper highlights a supplier's access to external channels of financing as an important criterion for the construction of supplier portfolios.

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**Figure 1.** Customer Cash Holdings over Time

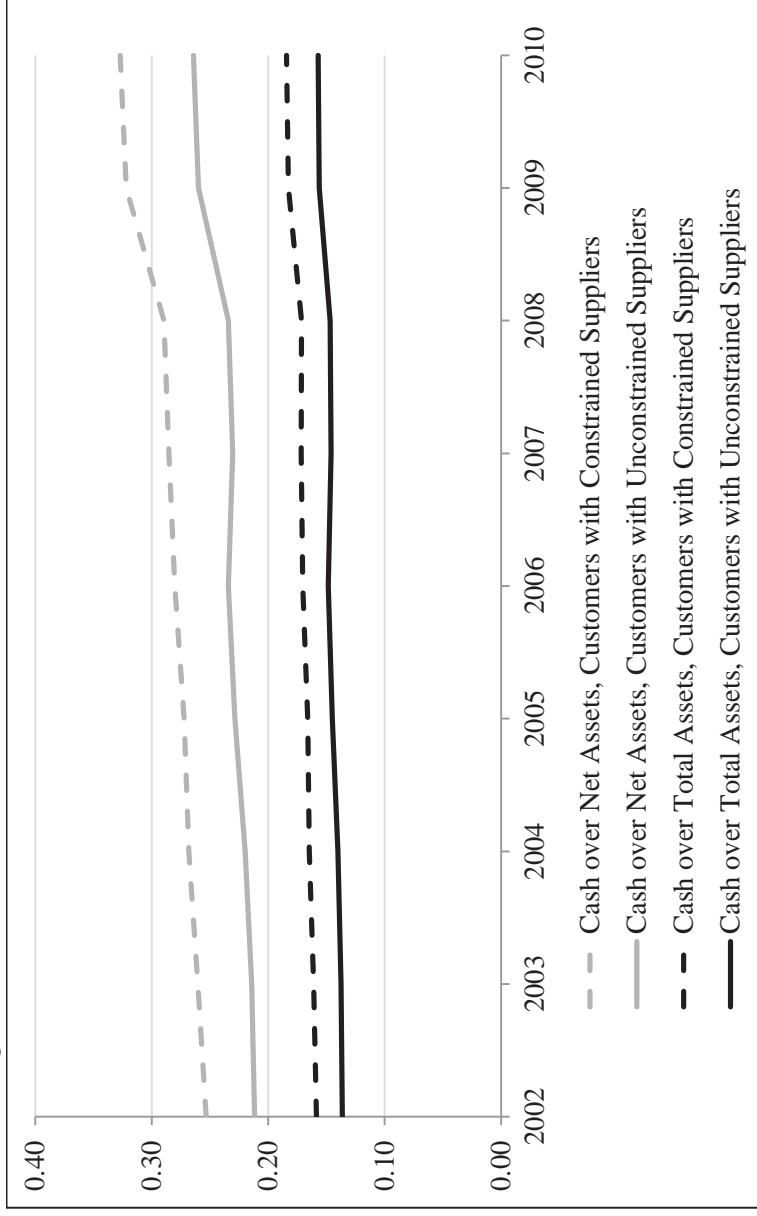


Figure 1. This figure depicts the average cash holdings of French non-financial customer firms with and without financially unconstrained suppliers over the span of our data set. A customer is considered as having unconstrained suppliers if at least one supplier is listed on a French stock exchange; constrained otherwise. Net Assets denotes Total Assets net of Cash. Variables are winsorized at 1% at the top and bottom tails.

**Figure 2.** Cash Holdings by Customer and Supplier Constraint

Cash Holdings of Constrained Customers		Cash Holdings of Unconstrained Customers	
With Unconstrained Suppliers	<	With Constrained Suppliers	With Unconstrained Suppliers $\approx$ With Constrained Suppliers

Figure 2. We test that cash holdings for constrained customers with unconstrained suppliers are *less* than the cash holdings for constrained customers with constrained suppliers. The counterfactual is that cash holdings for unconstrained customers with unconstrained suppliers are *not different* from the cash holdings for unconstrained customers with constrained suppliers.

**Figure 3. GDP and Investment in France**

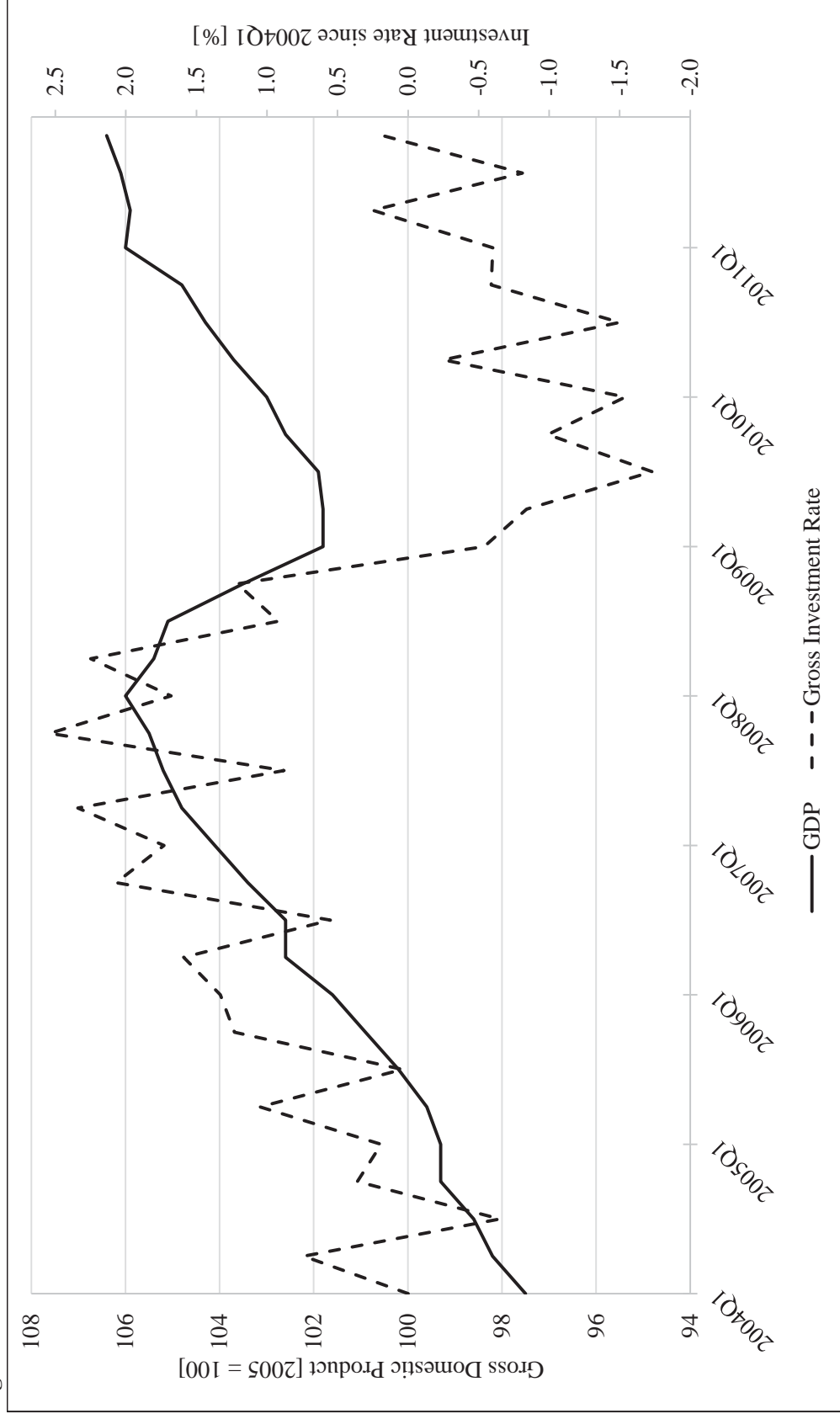


Figure 3. Quarterly development of Gross Domestic Product (GDP) and the Gross Investment Rate (GIR) from 2004Q1 to 2011Q4 in France. GDP is seasonally and calendar adjusted and indexed such that GDP in 2005 = 100. GIR is the difference in the ratio of gross fixed capital formation to gross value added between the current quarter and 2004Q1 for all non-financials. Source: Eurostat.

**Table 1.** Customer Descriptive Statistics

Baseline (2002 to 2010)	<i>n</i>	Mean	Std. Dev.	25%	Median	75%
Total Assets [€ thousand]	34,005	8,016.2	26,542.2	775.4	1,518.1	4,001.1
Age	34,005	26.9	15.0	16	23	33
Cash [€ thousand]	34,005	671.6	1,676.0	78.89	205.56	519.11
Cash/Total Assets	34,005	0.170	0.150	0.050	0.126	0.252
Cash/Total Assets Net of Cash	34,005	0.262	0.332	0.053	0.144	0.336
Trade Payables/Total Assets	30,379	0.255	0.146	0.147	0.234	0.341
Île-de-France Region:						
Outside	24,675					
Inside	3,624					
Pre-Crisis Period (2002 to 2006)						
Total Assets [€ thousand]	57,940	6,688.8	21,485.7	701.4	1,372.5	3,541.2
Age	57,940	26.8	14.9	16	22	34
Cash [€ thousand]	57,940	548.9	1,356.3	57.20	161.00	426.80
Cash/Total Assets	57,940	0.157	0.146	0.042	0.111	0.232
Cash/Total Assets Net of Cash	57,940	0.238	0.313	0.043	0.125	0.303
Île-de-France Region:						
Outside	39,061					
Inside	6,044					
Crisis Period (2008 to 2009)						
Total Assets [€ thousand]	62,771	7,620.8	23,955.5	834.5	1,620.5	4,132.0
Age	62,771	25.9	14.9	16	22	33
Cash [€ thousand]	62,771	628.7	1,515.9	54.00	184.00	511.00
Cash/Total Assets	62,771	0.163	0.165	0.032	0.107	0.249
Cash/Total Assets Net of Cash	62,771	0.267	0.393	0.033	0.119	0.331
Île-de-France Region:						
Outside	43,259					
Inside	6,687					

Table 1. This table depicts descriptive statistics for the customers in our sample. Total Assets Net of Cash is Total Assets minus Cash. All variables are winsorized at 1% at the top and bottom tails. Age is the number of years since incorporation to 2010. Data for trade payables is between 2006 and 2010. Île-de-France Region captures whether a customer is inside or outside the Paris region of France.

**Table 2.** Definitions and Sources of Variables

Treatment Variables Listed	Definition	Source
	1 if customer has at least one supplier that is, or ever was, listed; 0 if customer has all unlisted suppliers	CIPE; Amadeus
SA Index	1 if customer has at least one supplier in the tercile with the lowest SA indices; 0 if customer has all suppliers in the tercile with the highest SA indices	CIPE; Amadeus
Intangibles	1 if customer has at least one supplier in the tercile with lowest ratio of intangible-to-total assets; 0 if customer has all suppliers in the tercile with the highest ratio of intangible-to-total assets	CIPE; Amadeus
Other Variables	Definition	Source
Cash over Total Assets	$\overline{\text{Cash}}/\overline{\text{Total Assets}}$	Amadeus
Cash over Assets Net of Cash	$\overline{\text{Cash}}/(\overline{\text{Total Assets}} - \overline{\text{Cash}})$	Amadeus
Customer Size	$\log(\overline{\text{Total Assets}})$	Amadeus
Customer Age	$\log(2010 - \text{Year of Incorporation})$	Amadeus
Île-de-France	1 if customer is in the Paris region of France 0 if customer is outside the Paris region of France	Amadeus
Industry	Categorical variable corresponding to customer's industry section	Amadeus; INSEE

Table 2. Each of the treatment variables is coded such that a 1 corresponds to financially unconstrained suppliers and 0 corresponds to financially constrained suppliers. Where averages are defined, these correspond to the mean of the variable over the time period specified in the respective model. The INSEE is the French National Institute of Statistics and Economic Studies.



**Table 3.** Efficacy of Matching Algorithm

Treatment	Matching Covariate	Unmatched Sample			Matched Sample	
		Mean Constrained	Mean Unconstrained	Difference	Mean	Difference
<i>Listed</i>	<i>Customer Size</i>	7.582 (0.007)	8.061 (0.032)	-0.479*** (0.028)		-0.025*** (0.002)
	<i>Customer Age</i>	3.152 (0.003)	3.226 (0.010)	-0.074*** (0.011)		-0.001* (0.001)
<i>SA Index</i>	<i>Customer Size</i>	7.597 (0.016)	7.689 (0.010)	-0.091*** (0.019)		0.011*** (0.001)
	<i>Customer Age</i>	3.114 (0.006)	3.192 (0.004)	-0.078*** (0.007)		0.002*** (0.000)
<i>Intangibles</i>	<i>Customer Size</i>	7.513 (0.013)	7.722 (0.011)	-0.209*** (0.018)		0.012*** (0.001)
	<i>Customer Age</i>	3.123 (0.005)	3.191 (0.004)	-0.068*** (0.007)		0.002*** (0.000)

Table 3. This table depicts *t*-tests of differences in means for the continuous covariates in our baseline matching analyses for the 2002-2010 time period. *Customer Size* is the average of the natural logarithm of total assets over the time period, and *Customer Age* is the natural logarithm of the number of years since incorporation in 2010. Difference represents differences in means of each matching covariate between treated and control firms. All covariates are winsorized at 1% in both tails. Standard errors are shown in parentheses.

\*\*\*  $p < 0.01$ ; \*\*  $p < 0.05$ ; \*  $p < 0.10$

**Table 4.** Baseline Matching Estimates

Treatment	<i>Cash over Total Assets</i>		<i>Cash over Assets Net of Cash</i>	
	ATET	<i>n</i>	ATET	<i>n</i>
<i>Listed</i>	-0.011*** (0.003)	27,662	-0.024*** (0.007)	27,662
<i>SA Index</i>	-0.009*** (0.002)	22,291	-0.014*** (0.005)	22,291
<i>Intangibles</i>	-0.012*** (0.002)	21,312	-0.023*** (0.005)	21,312

Table 4. Results of NNM models for each measure of cash and each measure of supplier constraint for the period 2002 to 2010. Customers are matched on *Customer Size* (natural logarithm of average total assets), *Customer Age* (natural logarithm of number of years since incorporation in 2010), and are exactly matched on whether they are in the Paris region and by French industry section. *Customer Size* and *Customer Age* are winsorized at 1% in both tails of the distribution. The Average Treatment Effect on the Treated (ATET) is the difference in cash between customers with unconstrained suppliers and customers with constrained suppliers. Negative coefficients on the ATETs imply lower cash levels for customers with unconstrained suppliers. The minimum number of neighbors matched on is four. Standard errors are bias-adjusted. The number of observations refers to the total number of customers used in the analysis.

\*\*\*  $p < 0.01$ ; \*\*  $p < 0.05$ ; \*  $p < 0.10$

**Table 5.** Matching Analysis by Customer Constraint

<b>Panel A. Constrained Customers</b>				
Treatment	<i>Cash Over Total Assets</i>		<i>Cash Over Assets Net of Cash</i>	
	ATET	<i>n</i>	ATET	<i>n</i>
<i>Listed</i>	-0.010*** (0.003)	27,544	-0.023*** (0.007)	27,544
<i>SA Index</i>	-0.012*** (0.004)	6,732	-0.022** (0.009)	6,732
<i>Intangibles</i>	-0.010*** (0.003)	6,742	-0.015** (0.007)	6,742
<b>Panel B. Unconstrained Customers</b>				
Treatment	<i>Cash Over Total Assets</i>		<i>Cash Over Assets Net of Cash</i>	
	ATET	<i>n</i>	ATET	<i>n</i>
<i>Listed</i>	-0.040 (0.035)	51	-0.062 (0.048)	51
<i>SA Index</i>	-0.004 (0.004)	7,793	-0.004 (0.009)	7,793
<i>Intangibles</i>	-0.015*** (0.004)	6,965	-0.030*** (0.010)	6,965

Table 5. Results of NNM models for each measure of cash and each measure of supplier constraint for the period 2002 to 2010, split according to customer constraint. Depending on the respective treatment, customer constraint is measured by whether customers are listed or not, whether they are in the top or bottom third of customers according to their SA index values, and whether they are in the top or bottom third of intangibles-to-total assets for customers. Customers are matched on *Customer Size* (natural logarithm of average total assets), *Customer Age* (natural logarithm of number of years since incorporation in 2010), and are exactly matched on whether they are in the Paris region and by French industry Section. *Customer Size* and *Customer Age* are winsorized at 1% in both tails of the distribution. The Average Treatment Effect on the Treated (ATET) is the difference in cash between customers with unconstrained suppliers and customers with constrained suppliers. Negative coefficients on the ATETs imply lower cash levels for customers with unconstrained suppliers. The minimum number of neighbors matched on is four. Standard errors are bias-adjusted. The number of observations refers to the total number of customers used in the analysis.

\*\*\*  $p < 0.01$ ; \*\*  $p < 0.05$ ; \*  $p < 0.10$

**Table 6.** Pre-Crisis Period Cash Holdings

Treatment	<i>Cash over Total Assets</i>		<i>Cash over Assets Net of Cash</i>	
	ATET	<i>n</i>	ATET	<i>n</i>
<i>Listed</i>	-0.014*** (0.003)	44,577	-0.030*** (0.006)	44,577
<i>SA Index</i>	-0.007*** (0.002)	36,976	-0.012*** (0.004)	36,976
<i>Intangibles</i>	-0.012*** (0.004)	36,976	-0.013*** (0.002)	36,976

Table 6. Results of NNM models for each measure of cash and each measure of supplier constraint for the pre-crisis period 2002 to 2006. Customers are matched on *Customer Size* (natural logarithm of average total assets), *Customer Age* (natural logarithm of number of years since incorporation in 2010), and are exactly matched on whether they are in the Paris region and by French industry Section. *Size* and *Age* are winsorized at 1% in both tails of the distribution. The Average Treatment Effect on the Treated (ATET) is the difference in cash between customers with unconstrained suppliers and customers with constrained suppliers. Negative coefficients on the ATETs imply lower cash levels for customers with unconstrained suppliers. The minimum number of neighbors matched on is four. Standard errors are bias-adjusted. The number of observations refers to the total number of customers used in the analysis.

\*\*\*  $p < 0.01$ ; \*\*  $p < 0.05$ ; \*  $p < 0.10$

**Table 7.** Crisis Period Cash Holdings

Treatment	<i>Cash over Total Assets</i>		<i>Cash over Assets Net of Cash</i>	
	ATET	<i>n</i>	ATET	<i>n</i>
<i>Listed</i>	-0.011*** (0.003)	49,359	-0.027*** (0.007)	49,359
<i>SA Index</i>	-0.010*** (0.002)	38,200	-0.019*** (0.005)	38,200
<i>Intangibles</i>	-0.011*** (0.002)	36,518	-0.026*** (0.005)	36,518

Table 7. Results of NNM models for each measure of cash and each measure of supplier constraint for the crisis period 2008 to 2009. Customers are matched on *Customer Size* (natural logarithm of average total assets), *Customer Age* (natural logarithm of number of years since incorporation in 2010), and are exactly matched on whether they are in the Paris region and by French industry Section. *Size* and *Age* are winsorized at 1% in both tails of the distribution. The Average Treatment Effect on the Treated (ATET) is the difference in cash between customers with unconstrained suppliers and customers with constrained suppliers. Negative coefficients on the ATETs imply lower cash levels for customers with unconstrained suppliers. The minimum number of neighbors matched on is four. Standard errors are bias-adjusted. The number of observations refers to the total number of customers used in the analysis.

\*\*\*  $p < 0.01$ ; \*\*  $p < 0.05$ ; \*  $p < 0.10$

**Table 8.** Trade Payables

Treatment	<i>Trade Payables Over Total Assets</i>	
	ATET	<i>n</i>
<i>Listed</i>	0.008** (0.003)	27,260
<i>SA Index</i>	0.004* (0.002)	21,965
<i>Intangibles</i>	0.009*** (0.002)	21,014

Table 8. Results of NNM models for each measure of cash and each measure of supplier constraint for the period 2006 to 2010. *Trade Payables* is the average level of accounts payable for each customer over the time period. Customers are matched on *Customer Size* (natural logarithm of average total assets), *Customer Age* (natural logarithm of number of years since incorporation in 2010), and are exactly matched on whether they are in the Paris region and by French industry Section. All continuous variables are winsorized at 1% in both tails of the distribution. The Average Treatment Effect on the Treated (ATET) is the difference in cash between customers with unconstrained suppliers and customers with constrained suppliers. The minimum number of neighbors matched on is four. Standard errors are bias-adjusted. The number of observations refers to the total number of customers used in the analysis.

\*\*\*  $p < 0.01$ ; \*\*  $p < 0.05$ ; \*  $p < 0.10$

**Table 9.** Differentiated Goods and Services versus Standardized Goods

<b>Panel A. Cash over Total Assets</b>				
	Suppliers of Differentiated Goods and Services		Suppliers of Standardized Goods	
Treatment	ATET	<i>n</i>	ATET	<i>n</i>
<i>Listed</i>	-0.009*** (0.003)	27,584	-0.025 (0.017)	19,264
<i>SA Index</i>	-0.013*** (0.003)	11,588	-0.008*** (0.002)	18,173
<i>Intangibles</i>	-0.014*** (0.005)	8,304	-0.012*** (0.002)	20,138

<b>Panel B. Cash over Assets Net of Cash</b>				
	Suppliers of Differentiated Goods and Services		Suppliers of Standardized Goods	
Treatment	ATET	<i>n</i>	ATET	<i>n</i>
<i>Listed</i>	-0.022*** (0.008)	27,584	-0.051 (0.037)	19,264
<i>SA Index</i>	-0.026*** (0.007)	11,588	-0.011** (0.005)	18,173
<i>Intangibles</i>	-0.026** (0.011)	8,304	-0.022*** (0.005)	20,138

Table 9. Results of NNM models for each measure of cash and each measure of supplier constraint, broken down by the nature of the transacted good. *Trade Payables* is the average level of accounts payable for each customer over the time period. Customers are matched on *Customer Size* (natural logarithm of average total assets), *Customer Age* (natural logarithm of number of years since incorporation in 2010), and are exactly matched on whether they are in the Paris region and by French industry Section. All continuous variables are winsorized at 1% in both tails of the distribution. The Average Treatment Effect on the Treated (ATET) is the difference in cash between customers with unconstrained suppliers minus customers with constrained suppliers. The minimum number of neighbors matched on is four. Standard errors are bias-adjusted. The number of observations refers to the total number of customers used in the analysis.

\*\*\*  $p < 0.01$ ; \*\*  $p < 0.05$ ; \*  $p < 0.10$

**Table 10.** Summary Statistics Following Supplier IPO

	<i>n</i>	Mean	Std. Dev.	25%	Median	75%
Customers with Supplier IPOs (Treated)						
<i>ΔCash Over Total Assets</i>	185	-0.003	0.078	-0.024	0.000	0.026
<i>ΔCash Over Assets Net of Cash</i>	185	-0.009	0.183	-0.026	0.000	0.040
Customers without Supplier IPOs (Control)						
<i>ΔCash Over Total Assets</i>	740	0.009	0.045	-0.016	0.005	0.032
<i>ΔCash Over Assets Net of Cash</i>	740	0.023	0.099	-0.029	0.010	0.068

Table 10. Summary statistics regarding the change in cash holdings for customers with supplier IPOs (treated group) and matched customers without supplier IPOs (control group). All continuous variables are winsorized at 1% in both tails of the distribution. Customers are matched on *Customer Size* (natural logarithm of average total assets), *Customer Age* (natural logarithm of number of years since incorporation in 2010), and are exactly matched on whether they are in the Paris region and by French industry Section.



**Table 11.** Changes in Cash Holdings after Supplier IPO

	ATET	<i>n</i>
<i>ΔCash Over Total Assets</i>	-0.011* (0.006)	925
<i>ΔCash Over Assets Net of Cash</i>	-0.032** (0.015)	925

Table 11. Results of matching difference-in-difference models for each measure of cash holdings. For both models, the treatment is any supplier in a customer's portfolio undergoing an IPO. Customers are matched on *Customer Size* (natural logarithm of average total assets), *Customer Age* (natural logarithm of number of years since incorporation in 2010), and are exactly matched on whether they are in the Paris region, by French industry Section, and year. All continuous variables are winsorized at 1% in both tails of the distribution. The Average Treatment Effect on the Treated (ATET) is the difference in changes in cash holdings between customers with suppliers who went public and customers with suppliers who remained private. The number of neighbors matched on is four. The number of observations refers to the total number of customers used in the analysis.

\*\*\*  $p < 0.01$ ; \*\*  $p < 0.05$ ; \*  $p < 0.10$

## Appendix

### **A1. Further Analysis of Unconstrained Customers with Low Intangible Assets**

Our analysis here concerns the group of customers in Section 4.3 characterized as financially unconstrained with respect to their intangible assets. Since this group of firms is substantially smaller than all the other firms in our data set (around €2.5m less in total assets), it may be that although these customers are characterized as unconstrained with respect to their ratios of intangibles-to-total assets, they may be constrained with respect to their size. If this is indeed the case, we would expect the largest customers in this unconstrained-intangibles group to show no differences in cash holdings based on supplier constraint; large, unconstrained customers should not adjust cash holdings according to their suppliers' constraints.

We proceed by splitting the group of unconstrained (with respect to intangible assets) customers at their average (€6.4 million) and 75<sup>th</sup> percentile (€3.6 million) levels of total assets. These groups represent the largest customers with the lowest ratios of intangible-to-total assets in our data set. For each of the two groups, we specify matching estimators, matching customers on size, age, industry, and whether or not they are in the Paris region in France. Once more, the treatment in our analyses is whether or not these customers have unconstrained suppliers or not. The results of our analysis are presented in Table A1, where Panel A corresponds to customers above the mean level of total assets and Panel B corresponds to customers above the 75<sup>th</sup> percentile of total assets.

As expected, the cash holdings of unconstrained customers (those with the most total assets and least intangible assets) with unconstrained suppliers are not significantly different from the cash holdings of unconstrained customers with constrained suppliers. Complementing our findings from Section 4.3, we find evidence that the reduction in cash holdings due to supplier constraints is limited to those firms which are financially constrained themselves. In line with our hypothesis that reduced cash holdings stem from a relaxation in financial constraints, unconstrained customers with unrestricted access to external liquidity markets do not seem to be concerned with the ability of their suppliers to access external liquidity.

**Table A1.** Largest Customers with Lowest Intangible-to-Total Assets

<b>Panel A. Customers Above Mean</b>				
Treatment	<i>Cash over Total Assets</i>		<i>Cash over Assets Net of Cash</i>	
	ATET	<i>n</i>	ATET	<i>n</i>
<i>Intangibles</i>	-0.008	1,123	-0.023	1,123
	(0.012)		(0.025)	

<b>Panel B. Customers Above 75th Percentile</b>				
Treatment	<i>Cash over Total Assets</i>		<i>Cash over Assets Net of Cash</i>	
	ATET	<i>n</i>	ATET	<i>n</i>
<i>Intangibles</i>	-0.007	1,862	-0.019	1,862
	(0.009)		(0.020)	

Table A1. Results of NNM models for each measure of cash for the period 2002 to 2010, for customers with low ratios of intangibles-to-total assets and high levels of total assets. Customers are matched on *Customer Size* (natural logarithm of average total assets), *Customer Age* (natural logarithm of number of years since incorporation in 2010), and are exactly matched on whether they are in the Paris region and by French industry Section. *Customer Size* and *Customer Age* are winsorized at 1% in both tails of the distribution. The Average Treatment Effect on the Treated (ATET) is the difference in cash between customers with unconstrained suppliers and customers with constrained suppliers. The minimum number of neighbors matched on is four. The number of observations refers to the total number of customers used in the analysis. Standard errors are in parentheses.

\*\*\*  $p < 0.01$ ; \*\*  $p < 0.05$ ; \*  $p < 0.10$



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