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Supply-chain spillover effects of IPOs ☆

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ABSTRACT

We use the IPOs of supply-chain partners as precipitating events and test for positive spillovers on private firms (the "IPO spillover hypothesis"). A trading partner's IPO may benefit its suppliers through increased demand and its customers by reducing an input-related growth constraint. A newly public firm may also transmit additional liquidity to trading partners through trade credit practices. Using Japanese data on important relationships between IPO firms and their private suppliers and customers, we find that suppliers and customers experience significantly higher rates of growth in revenue, cash balances, and PP&E than do other private firms. The paper appears to be the first to document real and financial effects of positive liquidity shocks on supply-chain partners.

1. Introduction

Entrepreneurial firms and small and medium-size enterprises (SMEs) are commonly recognized to be more growth constrained than large firms and less likely to have access to formal sources of external finance (Beck and Demirguc-Kunt, 2006). An important concern is that growth potential may be impeded by a "funding gap" that can be severe for entrepreneurial firms.[1] Policymakers in many countries have sought to address this by establishing markets intended to enhance the ability of small firms to raise equity capital via public offerings.[2] An alternative that has received little attention is that non-public SMEs (referred to herein as "private firms") may benefit indirectly when their supply-chain partners access public equity markets. If the benefits are transmitted to private firms through supply-chain relationships or through improved access to capital, the concern with funding gaps is mitigated and the value of direct access to equity markets for small firms is reduced.

We examine private supply-chain trading partners of firms that have gone public via an initial public offering (IPO) and test the hypothesis that IPOs have significant spillover benefits for private suppliers and customers (the "IPO spillover hypothesis"). The IPO of a supply-chain partner serves as an exogenous shock to the private partner, which enables us to study growth spillover effects and liquidity transmission between public firms and related private firms.

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[1] See, e.g., Cressy (2002), a symposium addressing funding gap concerns facing entrepreneurial firms.

[2] Examples include the U.S. "Jobs Act" (Jumpstart Our Business Startups Act, 2011), which is aimed at helping companies with less than $1 billion in sales go public; the creation of the "MOTHERS" exchange (Market for High-Growth and Emerging Stocks) in Japan, where one listing requirement is approximately $10 million in net assets; the TSX Venture Exchange in Canada, where the listing requirements are $750,000 in net tangible assets, $500,000 in revenue, or $2 million in arms-length financing.

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The paper contributes to our knowledge of capital markets and corporate finance in three primary ways. First, this is the first study to address the important question of whether IPOs produce spillover benefits for private firms in the supply chain. Second, the study contributes to the literature on liquidity transmission by evaluating whether IPO firms transmit liquidity to private firms through their trade credit practices and/or by other means. Finally, the findings have implications for economic growth and development. Consistent with Beck and Demirguc-Kunt (2006), we find that well-functioning capital markets can reduce growth constraints on firms that remain private.

To test the empirical implications of the IPO spillover hypothesis, we require detailed financial data on private firms and on their supplier and customer relationships. This type of information is not generally available in the US, but it is in Japan. Drawing on several sources, we construct a database of private firms and their most important suppliers and customers and then identify which of those supply-chain partners go public in a given calendar year.

Using both the full sample and a sample of firms matched to the subject private firm by industry, year, and size, both private suppliers and customers of IPO firms experience significantly higher rates of revenue growth. Higher revenue growth rates are accompanied by higher rates of growth in cash balances, and property, plant and equipment (PP&E). Through more detailed investigation, we find that these spillover benefits to cash balances and PP&E arise mainly through revenue increases for suppliers and customers of the IPO firm.

IPO firms can provide liquidity to suppliers by paying more quickly and to customers by allowing them to pay more slowly. Difference-in-differences tests indicate that suppliers have higher rates of accounts receivable (AR) growth after their customers' IPOs than do matched private firms that are not partners of IPO firms. However, matching on industry, year, and size, and controlling for revenue growth and other factors, the growth of AR is not significantly different for suppliers of IPO firms than for other private firms. The AR evidence, on its face, suggests that prior to their IPOs, IPO firms had not overly relied on trade credit financing from private suppliers. We caution that the actual effects of customers' IPOs on private suppliers' AR can be masked when suppliers sell material fractions of their receivables to lenders for cash and retain a contingent liability in the form of a discounted note, a practice that is analogous to factoring. In this case, the benefit to suppliers can appear more as an increase in cash balances than a reduction in AR. Miwa and Ramseyer (2008) report that discounting AR to banks for cash is common in Japan across a broad range of industries and firm sizes.[3] Our evidence is consistent with this possibility in that private suppliers of IPO firms experience higher rates of cash balance growth than do comparison or matched firms.

In difference-in-difference tests, and to a lesser extent in multivariate tests, customers of IPO firms have significantly higher rates of AP growth after the IPO than do firms that are not customers of IPO firms. The multivariate evidence indicates that higher rates of AP growth are partly associated with the higher rates of revenue growth that accompany IPOs. Regarding working capital transmission, there is limited evidence that IPO firms actively seek to transfer liquidity to private customers, which is not surprising in an environment where firms commonly sell their AR to banks for cash and banks have little incentive to engage in forbearance of collections.

Because discounting AR can mask the transmission of liquidity, as a robustness check of how private firms benefit from the IPOs of supply-chain partners, we test whether the IPO is associated with a generalized improvement in private firm liquidity. For this, we examine changes in overall liquidity surrounding the partner's IPO. Using a widely accepted measure of financial constraints (Kaplan and Zingales, 1997), compared to matched private firms, we find statistically significant and material reductions in the financial constraints of private suppliers and customers of IPO firms.

In Section 2, we use previous literature to develop the empirical implications of the IPO spillover hypothesis. Section 3 describes the dataset and method used to identify the private firms and their linked IPO firms. Section 4 provides definitions of variables used in the analysis, along with summary statistics. Section 5 presents the empirical analysis and robustness checks. Section 6 concludes.

2. Previous literature and hypothesis development

Most studies of spillover effects focus on negative firm-specific liquidity shocks like bankruptcy or negative aggregate shocks like financial crises. Often, these studies focus on stock price reactions of rivals or firms in the supply chain. The supply-chain studies we could identify focus exclusively on negative shocks.

There are reasons to expect that responses to positive shocks could be different from those to negative shocks. Accordingly, we focus on how a positive shock, an IPO, affects non-public trading partners. In contrast to studies of stock price reactions, we examine real and financial effects on supply-chain partners. Real effects are manifested as changes in variables such as revenue and tangible assets. Financial effects are manifested as changes in financial assets and liabilities such as trade receivables and payables, bank loans, and cash.

An IPO is an important liquidity event for the issuer since it provides an infusion of cash that can be used for financial restructuring and to fund growth. A partner's IPO may also benefit suppliers through increased demand and benefit customers by reducing an input-related growth constraint. Beyond the direct effects, a supply-chain relationship to a public firm can enhance product-market credibility and demand and increase access to funding sources. Moreover, prior to the IPO, the firm could have been impaired in its ability to grow and may have funded its operations partly by over-reliance on vendor financing and by limiting credit to customers. If so, after the IPO, private trading partners may benefit if the firm pays more quickly or allows customers to pay more slowly.

2.1. Previous literature

Liquidity propagation through the supply chain is modeled theoretically by Kiyotaki and Moore (1997). In their model, a negative shock causes financial difficulties further up the chain and can trigger financial failure of the overall economy.[4] Coricelli and Masten (2004) show theoretically that trade credit can also propagate shocks downstream if suppliers with liquidity problems reduce credit to customers.[5] Economic reasoning suggests that both positive and negative shocks can propagate through supply-chain relationships and can also have horizontal effects, but extant evidence is limited to negative shocks.

A set of papers relevant to our analysis examines the effects of firm-specific shocks on vertically or horizontally related firms.

[3] Mian and Smith (1992) provide theory and evidence on variations in accounts receivable management policies, including use of factoring, bank discounting of receivables, receivables-secured debt, and internal management of receivables.

[4] See also Allen and Gale (2000), who model the propagation of liquidity shocks through networks between firms and financial intermediaries.

[5] Raddatz (2010) supports Kiyotaki and Moore (1997) using a multi-country industry-aggregated input–output relationships. The evidence is indirect since Raddatz is unable to examine firm-to-firm relationships.

These include studies of negative shocks like bankruptcy, and the negative impact of shocks like IPO announcements on rivals. In contrast to our study, they focus on spillovers to public firms, and generally concentrate on stock price reactions. While a price reaction can signify the occurrence of a spillover, it does not reveal the nature of the spillover.

Lang and Stulz (1992) find that rival stock prices react positively to bankruptcy announcements but indicate that they cannot tell whether stock price reactions are causal or just information effects. Hertzel et al. (2008) extend Lang and Stulz to suppliers and customers. They find that bankruptcy has a negative impact on supplier stock prices but a weaker impact on customers. Like Lang and Stulz, they cannot distinguish information effects from impact. In a comparison to matched firms that is similar to our difference-in-difference analysis, Boone and Ivanov (2012) find that stock prices react negatively to bankruptcy announcements by strategic partners. They also document negative real effects (declining profit margins and investment) after the bankruptcy. Johnson et al. (2011) endogenize reported customer relationships and examine returns. They find that when firms announce seasoned equity offers, customers' stock prices react negatively, which they interpret as indicative of concern about the supplier and market.

Braun and Larrain (2009), looking at stock price reactions, find that when a firm goes public, the increased supply of shares induces negative reactions in the prices of firms with highly correlated stock returns. In their analysis, spillover effects are on rivals and relate only to share value, with no necessary real effects of the IPO. Hsu et al. (2010), in a research design similar to our own, deal with endogenity concerns by testing real effects on rival public firms in addition to stock price reactions, and by modeling real effects using prior performance growth as a control and an IPO dummy for rival firms. They find that IPO announcements cause negative abnormal stock price reactions of rivals and negative operating performance.

2.2. Transmission to supply-chain partners

While these empirical studies provide evidence of stock price reactions and real effects in response to important liquidity events for related firms, they do not address the question of whether a firm's liquidity change is transmitted to vertically related firms, and if so, how it is transmitted. Among other things, an IPO can affect the extent to which a supply chain partner is able to rely on vendor financing from suppliers or provide vendor financing to customers, gain increased access to bank financing, or increase cash balances.

As is well-recognized, trade credit is an important form of financing to small businesses, both as providers and users.[6] While the literature does address the question of how customer–supplier relationships affect trade credit provision, it has not been extended to examine how a liquidity event, like an IPO, can impact related private firms through trade credit practices, growth spillovers, or complementarity with other financing.

Trade credit is offered in the context of asymmetric information.[7] Concerns about a supplier's reliability can be reduced by terms that delay payment, which gives the customer time to verify that product quality is as promised. Concerns about a customer's reliability can be addressed by recognizing that the customer's failure to take advantage of a prompt payment discount can signal financial difficulty.[8]

Transmission of liquidity through the supply chain is most likely to stimulate investment when the private partner is liquidity constrained. In an early study of responses to negative shocks, Meltzer (1960) finds that firms with large cash balances increased the time over which trade credit was extended to illiquid customers. Love et al. (2007) build on existing theories to examine how financial crises affect trade credit provision in emerging economies. They find that credit is redistributed from stronger to weaker firms.

Firms in the supply chain, through their extension of trade credit, effectively act as substitutes for formal financial intermediaries. Molina and Preve (2009, 2012) find (2009) that firms facing financial distress increase receivables in the face of profitability declines, but reduce receivables when confronted with cash flow problems. In the later study (2012), they find that distressed firms increase reliance on trade payables. Atanasova (2007) finds that formal financing is less available to distressed firms and that the firms substitute into greater reliance on trade credit. Uesugi and Yamashiro (2008), in a study of Japanese small firms, find that bank loans and AP tend to move together in response to monetary shocks, indicating that trade credit financing and bank loans are used as complements. Other literature also points to a complementary role for trade credit and bank loans. Levy (2010) and Alphonse et al. (2004) find that trade credit and bank financing are complementary in that use of trade credit increases access to bank loans.

Notably, the studies to date establish that firms respond to negative shocks by increasing reliance on trade credit. The decision to do so is largely controlled by the borrower through the election to forgo a prompt payment discount, or to rely on forbearance by the trade credit supplier when a firm delays payment beyond the net period (Petersen and Rajan, 1994). Responses to positive events may be different. A firm that goes public gains liquidity that it can use to reduce AP, but doing so is likely only if the IPO firm had previously been overly reliant on vendor financing or wanted to intentionally transfer liquidity to suppliers. It could also increase its own AR by offering more generous terms or through forbearance in enforcing terms. However, Ng et al. (1999) find that trade credit terms are set in competition and standardized by industry so that unilaterally offering more generous terms seems unlikely.

The above considerations suggest that positive liquidity events are less likely to be associated with liquidity transmission through trade credit than are negative liquidity events. With negative shocks the provider of trade credit (the healthier firm) doesn't have to change terms or actively offer more credit; rather they can act passively, allowing the credit user to take longer to pay. But with positive shocks, transmission of liquidity would require the IPO

[6] Bougheas et al. (2009) report on trade credit as a major element of corporate finance worldwide. In a comprehensive study of US small business, Berger and Udell (1995) find that trade credit accounts for 31% of debt financing and is 2.9 times as large as all angel and venture capital financing combined. Based on the most recent Federal Reserve Board Survey of Small Business Finances (2003), Mach and Wolken (2006) estimate that 60% of small businesses use trade credit. On the flip-side, based on a 2012 survey of its members, the US National Association of Small Businesses estimates that 84% sell on credit, and about 30% offer net terms as long as 60–90 days. Vendor financing is especially important in economies with less developed financial markets and for start-ups with little collateral and limited access to bank loans. For example, Ge and Qiu (2006) provide evidence on the importance of trade credit in China.

[7] Smith (1987) develops a model where trade credit terms are designed to reveal concerns about customer performance. Petersen and Rajan (1997) argue that firms provide credit to customers when bank financing is not available because suppliers can get information from their customers inexpensively, are able to liquidate reclaimed inventory, and have stakes in customer survival. Kim and Shin (2012) demonstrate that delayed payments, which are implicit in interfirm credit relationships, can mitigate incentive problems.

[8] According to Uesugi and Yamashiro (2008), explicit discounts for prompt payment are not typical in Japan. Rather, trade credit is "free" financing through the net period, beyond which the customer would be in breach. Uchida et al. (2010) report that only 6–11% of firms in their sample offer an early payment discount or explicitly assess a late payment penalty.

firm to proactively relax terms for customers and pay suppliers more quickly.

2.3. Hypotheses

We first develop hypotheses related to effects on revenue and PP&E growth for trading partners of the IPO firm. If there are real spillovers, IPOs will be associated with higher growth rates of revenue and PP&E for suppliers and customers than for other firms that are not trading partners of IPO firms. Second, we develop hypotheses related to financial effects whereby the enhanced liquidity of the IPO firm may be transmitted to trading partners through: increased availability of trade credit, increased access to bank loans, increased cash balances.

2.3.1. Growth of revenue and investment in property plant and equipment

Several empirical studies of the choice to go public focus on product market considerations. Pagano et al. (1998) find that firms in Italy go public to rebalance capital structure after periods of high growth and investment. In a study of US firms, Chemmanur et al. (2010) find that revenue is consistently increasing before and after the IPO at rates faster than those of private comparison firms. Jong et al. (2012) report that firms that go public in the UK are able to achieve more rapid revenue and market share growth after the IPO.

If supply-chain relationships are valuable to private firms, we expect IPOs to be associated with higher revenue growth for private partners. As indicated by the above studies, IPOs are more likely for firms that have experienced high revenue growth and also to fund the growth after the IPO. Growth of the IPO firm is expected to result in increased purchases from suppliers and relaxation of limitations on ability to supply customers. Relationships between IPO firms and their suppliers and customers also may bring increased attention to the private firms or effectively certify their products to other purchasers. A contrary argument, which we implicitly test and reject, is that the IPO may enable the IPO firm to substitute away from its existing partners, giving rise to a negative relationship between the IPO and revenue growth of supply-chain partners.

Hypothesis 1a. Relative to other private firms, revenue growth rates of suppliers will be higher around the IPOs of important customers.

Hypothesis 1b. Relative to other private firms, revenue growth rates of customers will be higher around the IPOs of important suppliers.

Firms that seek to maximize returns to investors will make investments in productive assets based on anticipated demand. The productive assets we study are investments in PP&E. Firms that operate with efficient levels of PP&E and that achieve or anticipate sustained higher levels of revenue are expected to increase investments.

Hypothesis 2a. Relative to other private firms, PP&E growth rates of suppliers will be higher around the IPOs of important customers.

Hypothesis 2b. Relative to other private firms, PP&E growth rates of customers will be higher around the IPOs of important suppliers.

Fazzari et al. (1988) provide the theoretical underpinnings for this hypothesis, arising from the literature on interdependence of investment and financing decisions. When firms face financial constraints, as is likely for private firms, these constraints will affect investment behavior. It follows that a positive liquidity event, such as the IPO of a trading partner, will ease the financing constraints facing private supply-chain partners. Enhanced access to financing or increased cash flow from sales, give rise to increased investment.

2.3.2. Liquidity transmission across the supply chain

Liquidity may be transmitted to private supply-chain partners in a variety of ways, including directly through trade credit practices and policies, increased cash resulting from selling (discounting) AR, improved access to formal bank financing, and improved cash flow associated with scale. Direct effects on suppliers' AR balances and customers' AP balances can occur when an IPO firm pays suppliers more quickly and/or allows customers to pay more slowly.

As noted, the direct impact on AR can be masked if private suppliers routinely sell their receivables to banks in exchange for cash (Miwa and Ramseyer, 2008). Such transactions remove AR from the supplier's balance sheet and increase the cash balance. The practice of discounting AR is similar to factoring that is common in many countries and to pledging ARs as collateral on loans, although the accounting is different. Hence, for evidence of liquidity transmission we must examine changes in both AR and cash balances. Also, as discussed, there is little reason to expect an IPO firm to accelerate payment unless it previously had been overly reliant on trade credit. Correspondingly, if newly public firms liberalize their trade credit terms or are more accepting of payment delays, we expect liquidity to be transmitted to private customers through a higher AP growth rate of the customer. However, because, as noted, two-part terms are rare in Japan, there may be little effect on AP balances unless a customer is liquidity constrained.

Cash balances may also increase for other reasons related to the IPO. For example, the IPO could enable supply-chain partners to achieve greater scale and operate more efficiently, with increased cash flow from operations. Also, if lenders regard the IPO as an indication of the credit worthiness of the private partner, the IPO could support greater access to formal loan financing for the private partner, which could be of value to a liquidity constrained private partner.[9]

To our knowledge, this is the first empirical study to address the transmission of firm-specific positive liquidity shocks through the supply chain. Based on the firms in our analysis, IPO firms do appear to adopt more liberal trade credit practices after their IPOs. However, the movement is modest and the ratio of AR to AP increases gradually – by about 35% over the 5 years after the IPO. Fig. 1 shows the median ratio of AR to AP for the IPO firms. After the IPO, newly public firms move in the direction of being net suppliers of trade credit. Here, again, the effect is understated to the extent that IPO firms sell their AR to banks for cash.

Controlling for the rate of revenue growth, if newly public customers of private suppliers have been overly reliant on trade credit and use their enhanced liquidity to support suppliers by paying for purchases more quickly, AR growth rates of suppliers are expected to decline. This expectation is reflected in Hypothesis 3a below. As noted, the practice of selling AR for cash works against this hypothesis. As an additional test, we consider whether, controlling for other factors, AR grow more slowly than revenue. A significantly lower AR growth rate would indicate that IPO customers of high-growth suppliers are paying more quickly.

[9] Conversely, if a private supplier is not liquidity constrained and regards the IPO as strengthening the credit quality of the IPO firm, a private supplier might respond by increasing available trade credit, in which case the supplier's AR balance could increase.

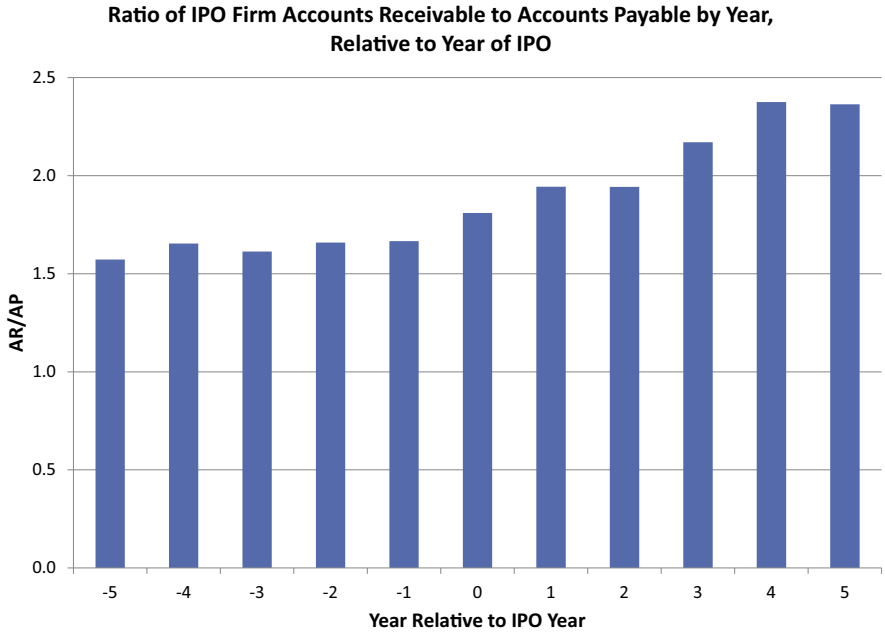

Fig. 1. Median ratio of IPO firm accounts receivable to accounts payable by year, relative to IPO year. The figure is based on the sample of Japanese IPO firms used in our analysis. Beginning in the IPO year, firms increase their net trade credit, indicating lower reliance on vendor financing and/or more forbearance in collection of accounts receivable.

Similarly, if newly public firms liberalize their trade credit terms or are more accepting of payment delays, we expect liquidity to be transmitted to private customers through a higher AP growth rate of the private firm. In Japan, where prompt payment discounts are not the norm, we expect customers of IPO firms to maintain their reliance on trade credit and expect the AP growth rate around the IPO to be proportionate to the rate of increase in revenue. The potential to find evidence of forbearance is reduced to the extent that IPO firms sell their ARs to banks.

Hypothesis 3a. Relative to other private firms, AR growth rates of suppliers will be lower around the customer's IPO.

Hypothesis 3b. Relative to other private firms, if customers are liquidity constrained and IPO firms are willing to forebear prompt collection, the AP growth rates of customers will be higher around the supplier's IPO.

Supplier-provided trade credit and bank loans are alternative ways for a customer to gain liquidity.[10] Similarly, for private suppliers, bank financing is an alternative to prompt collection of receivables or to selling receivables at a discount. If banks view private firms more positively based on the IPO of a supply-chain partner, changes in bank financing can reduce dependence on supply-chain relationships.

A customer's IPO can increase the quality of receivables from that customer. This may enable the supplier to use AR as collateral for formal bank loans. Levy (2010) points out that while the values of most firm assets are related to its performance, the value of AR depends on its customers. The US Comptroller of the Currency, Administrator of National Banks (2000, pp. 29, 44) establishes that bank lending policy should depend on AR quality, taking into consideration "the overall quality of the borrower's customer base (e.g., publicly rated companies, ...)" and any "shift" in the base. This proscription suggests that an IPO, by increasing AR quality, can augment the ability to borrow.

While a partner's IPO can strengthen the reputations of both suppliers and customers, expectations about effects on bank loans are different for customers than for suppliers. Customers may gain credibility with lenders but not find it profit maximizing to increase their borrowing. Since trade credit is essentially free financing during the net period, we expect Japanese firms only to increase borrowing to the extent that vendor financing is not adequate and to sell AR to banks as an alternative to formal borrowing.[11] Hence, the more widespread the practice of discounting of receivables, the less likely we are to observe growth in loans.

Hypothesis 4a. Relative to the growth of bank loans of other private firms, the loan growth rates of suppliers will be higher around the IPOs of important customers, but the incentive to increase formal borrowing is mitigated by the (unobservable) practice of selling accounts receivable to banks for cash.

Hypothesis 4b. Relative to the growth of bank loans of other private firms, the loan growth rates of customers who seek additional liquidity will be higher around the IPOs of important suppliers.

Cash balance increases of private firms can result from accelerated collection of receivable, sales of receivables to banks, increased profitability, relaxation of payment terms for purchasing, increases in outside financing, or retention of resources as opposed to distribution. Supply-chain relationships and improved liquidity of newly public firms imply that cash balance growth rates of private supply-chain partners will be positive.

Hypothesis 5a. Relative to cash balance growth rates of other private firms, the growth rates of suppliers will be higher around the IPO of important customers.

[10] Trade credit and bank credit are related. Nilsen (2002), for example, finds that firms increase reliance on trade credit when monetary contractions reduce access to loans. Also see Guariglia and Mateut (2006), and the previously discussed study by Uesugi and Yamashiro (2008).

[11] Because net periods vary widely and we do not know the terms offered by any specific firm, we cannot assess whether a firm is overly reliant on trade credit.

Hypothesis 5b. Relative to cash balance growth rates of other private firms, the growth rates of customers will be higher around the IPO of important suppliers.

Because of the Japanese practice of selling AR to banks it is not clear whether, controlling for other factors, transmission of liquidity to suppliers will be reflected in a lower AR growth rate. More generally, because private partners of IPO firms have a menu of ways to benefit from liquidity transmission, the implications for individual balance sheet accounts are complex. As a robustness check, we test for an overall increase in liquidity, using the financial constraint index developed by Kaplan and Zingales (1997) and estimated by Whited and Wu (2006) – the KZ Index. In the Whited and Wu empirical estimates, financial constraints are negatively related to cash flow, dividends, and cash balances, and positively related to long-term debt and Tobin's Q. If IPO firms transfer liquidity to supply-chain partners, we expect a reduction in the financial constraints index around the time of the IPO.

3. Data

We first identify the supply-chain relationships of private firms and then assess whether any relationship is with a firm that went public during the accounting period of the private firm. Financial and supply-chain data on private firms are from the *Cosmos* database provided by Teikoku Databank. The database contains financial reports and firm-attribute data that include each firm's top 5 suppliers and customers. Names and securities codes of IPO firms are from the IPO White Book (*Kabushiki Koukai Hakusho*) published by Pronexus. Detailed information on the number of shares offered and the numbers of primary and secondary shares is from the Corporate Finance Equity Issue Database in the Financial QUEST service provided by Nikkei Media Marketing.

The dataset consists of private firms with paid-in capital exceeding ¥80 million (about $800 thousand) and excludes wholly-owned subsidiaries, cooperatives, public utilities, and financial firms.[12] The dataset available to us covers 1993 through 2005 and includes 11,632 private firms as of 1993, 11,671 as of 2005, and a total of 168,498 firm-year observations. The number of IPOs during our sample period is 1881. Using the customer and supplier data, we are able to link private firms to 973 of these IPO firms as supply-chain partners ("linked" firms).

The empirical analysis is organized around the private firm's accounting period. We define period 0 as the accounting period during which a trading partner goes public. A private firm that lists an IPO firm in its top 5 suppliers or customers in the year of the IPO is identified as linked with the IPO firm in that year. The list of customers and suppliers contains 126,327 unique company names, for a total of 1,371,143 records over the sample period. Because supply-chain partners are identified only by name, linking requires textual comparisons.[13]

[12] Private firms in the sample are unlikely to have *keiretsu* relationships, as these are normally relationships among larger firms that are public. To evaluate, we compared the top 5 shareholders list for each private firm to the top 5 shareholders list for each IPO firm and then counted the cases having a common major shareholder. We found only 13 cases of cross-ownership. Thus, the *keiretsu* structure of some Japanese firms is not material to our analysis.

[13] The list of names in the *Cosmos* database is constructed phonetically. Because names are written as text, the same firm may appear in several ways. Linking errors may occur from typographical errors, translation from Japanese *Kana* characters to alphabetical, mixed use of lower and uppercase, or inclusion of blanks. For example, "WOWOW," the broadcasting service company on the Tokyo Stock Exchange (TSE) MOTHERS Index is sometimes notated as WOWOW and sometimes as "*wa u wa u.*" In the original dataset, it appears in *Kana* characters. We also verify firms with Japanese lowercase and uppercase letters. For example, "*wa u wa u*" is noted as "*wa lu wa lu,*" where "*lu*" is the lower case of "*u*". We interpret these varying names as applying to the same firm. To the extent possible, we manually correct discrepancies.

In our dataset, 4609 private firms have supply-chain relationships with firms that go public during the private firm's fiscal year. Table 1 reports the numbers of private firm/IPO firm linkages by calendar year. Private firms are suppliers in 2536 cases and customers in 2073 cases.

In Table 2, we report the number of supply-chain partners for each IPO firm. Suppliers are linked with 734 unique IPO firms and customers are linked with 599. In most cases the IPO firm is linked to one private firm, or a small number. On average, each IPO firm is a customer of 3.455 private firms and each is a supplier to 3.461. We examined the durability of these relationships by computing the percentages of suppliers or customers who were listed as the top 1 in the year before the IPO and remained in the top 5 in the year after the IPO. For suppliers, 77.6% remain in the top 5 and for customers 80.3% do. These percentages are similar

Table 1
Private firm/IPO linkages by calendar year.

Year	Number of supply-chain linkages	Suppliers of IPOs	Customers of IPOs	Percent of suppliers (%)	Percent of customers (%)
1993	173	92	81	3.6	3.9
1994	404	249	155	9.8	7.5
1995	573	293	280	11.6	13.5
1996	556	225	331	8.9	16.0
1997	354	198	156	7.8	7.5
1998	341	191	150	7.5	7.2
1999	212	125	87	4.9	4.2
2000	359	176	183	6.9	8.8
2001	500	265	235	10.4	11.3
2002	455	305	150	12.0	7.2
2003	200	102	98	4.0	4.7
2004	209	135	74	5.3	3.6
2005	273	180	93	7.1	4.5
Total	4609	2536	2073	100.0	100.0

The table shows the total number of private firm/IPO firm linkages by calendar year in which the IPO occurs, the numbers of observations where the private firm is a supplier or customer, and percentage breakdowns over time. Statistics are based on the *Cosmos* dataset provided by Teikoku Databank and the IPO White Book (*Kabushiki Koukai Hakusho*) published by Pronexus.

Table 2
Statistics on linkages of IPO firm to private-firm suppliers and customers.

Number of private firm links	Suppliers of IPO firms		Customers of IPO firms	
	No. of IPO firms	Cum. (%)	No. of IPO firms	Cum. (%)
1	342	46.6	280	46.7
2–5	309	88.7	238	86.5
6–10	47	95.1	47	94.3
11–20	22	98.4	21	97.8
21–30	9	99.5	6	99.0
31–40	0	99.5	5	99.7
41–50	1	99.7	0	99.7
51	4	100.0	2	100.0
Number of IPOs	734		599	
No. of private firm/IPO firm links	2536		2073	
Mean number of links/IPO firm	3.455		3.461	
Median number of links/IPO firm	2		2	

This table reports results of the identification of private firm/IPO firm linkages. The table shows the number of times an IPO firm is identified as a supplier or customer in the supply chain, as well as the numbers of unique IPO firms partnered with suppliers and the number partnered with customers. Statistics are based on the *Cosmos* dataset provided by Teikoku Databank and the IPO White Book (*Kabushiki Koukai Hakusho*) published by Pronexus.

Table 3
Size distribution of private firms.

Variable	Mean	St. Dev.	p25	p50	p75
All private firms					
Assets	11,135,523	53,298,889	1,812,038	3,983,279	8,902,374
Revenue	12,930,529	48,898,912	2,154,738	4,854,888	11,087,562
Suppliers of IPO firm					
Assets	8,487,856	28,768,619	1,467,013	3,260,658	8,041,031
Revenue	11,407,883	30,568,233	1,935,434	4,392,593	10,409,317
Customers of IPO firms					
Assets	13,541,270	62,902,021	1,509,105	3,762,642	8,889,110
Revenue	14,896,096	52,668,086	1,925,971	4,796,746	11,188,522

Based on a sample of 168,498 firm-year observations from 1993 through 2005, including 2536 suppliers of IPO firms and 2073 customers. Figures are in thousands of Yen (100 Yen ≈ 1 US Dollar). *Source:* Teikoku Databank, *Cosmos* database.

to the annual turnover percentages over other one-year intervals from year −5 through year +5. Assuming time-series independence, the relationship half-life is about 3.2 years for suppliers and 3.6 customers. These are likely to be underestimates since we cannot observer relationships below the top 5.

Table 3 shows the size distribution of private firms in the analysis. Not all private firms are small, but a material fraction are. The median total asset size in the sample is 3.98 billion Yen (about $40 million), the median for suppliers is 3.26 billion Yen, and the median for customers is 3.76 billion. The bottom quartiles are less than half as large as the medians.

Table 4 reports the industry distribution of linked private firms and the corresponding industry of IPO firms. Classifications are based on two-digit Nikki Middle Industry Classification codes.[14] The column corresponding to a given private-firm industry indicates the numbers of related IPOs by industry. The row corresponding to a given IPO industry indicates the numbers of related private firms by industry. Both private firms and IPO firms are somewhat concentrated in wholesaling (industry 43) with 25.7% of the private-firm observations and 25.4% of the IPO observations, and in services (industry 71) with 25.5% of the private firms and 22.1% of the IPOs.[15] The right two columns report the numbers and percentages of pairs where both firms belong to the same industry. Overall, 28.9% of the linked dyads belong to the same industry.

Industry concentrations and same-industry supply-chain partnerships are similar for observations where the private firm is the supplier and where it is the customer. For the private supplier sample, wholesaling accounts for 26.0% of private firms and 17.4% of IPOs; services accounts for 25.7% of private firms and 24.3% of IPOs; and same-industry matches comprise 30.1% of the sample. For the customer sample, wholesaling accounts for 25.3% of private firms and 35.2% of IPOs; services accounts for 25.3% of private firms and 19.3% of IPOs; and within-industry matches comprise 27.3%. In the empirical analysis, we exclude Real Estate and Railroads, where standard notions of trade credit do not apply and which account for few observations.

4. Empirical approach, variable definitions, and summary statistics

We use two different control groups to examine IPO spillover treatment effects. First, we define a treatment observation as a firm-year where a supply chain partner went public and define a control observations ("comparison" firms) as firm-years when no partner went public. Second, we adopt a matched-firm approach similar to that of Asker et al. (2011). For this, we match each linked private firm to a specific non-linked private firm ("matched" firms). We match first on year and industry and then on size. For the size match, we restrict prospects to firms with total assets that are more than 0.5 and less than 2.0 times that of the linked firm in the same year. We then select the firm with the closest ROA in the prior year (ROA_{t-1}) and designate it as the matched firm. All private firms in the same industry and year that are not linked with IPO firms are eligible to be selected as matched firms.

Corresponding to the two approaches to identifying the control sample, we use two methods to investigate the impact of IPOs on private supply-chain partners. The first is a bivariate difference-in-difference approach where we test whether the mean or median percentage change in the variable of interest (e.g., revenue) from before to after the treatment is significantly different from the change over an interval of the same duration in the control sample. The second is multivariate regression approach, where instead of matching, we control for industry and year by including fixed effects and include control variables for size, profitability, and other factors.

4.1. Dependent variables

To examine the real impacts of IPOs on private partners, we test the relation between the IPO and the private firm's growth rates of revenue and PP&E. To better understand the transmission of liquidity from IPO firms, for private suppliers (customers), we estimate the relations between the IPO and the supplier's (customer's) growth rates of AR (AP), loans, and cash.

In the difference-in-difference analysis, changes in variables are measured over two-year intervals surrounding the partner's IPO and the test is whether the mean or median change are significantly different between the treatment group and either the comparison or matched control group. The change in revenue, for example, is measured as the geometric average annual percentage change over the two-year interval from t to T, where t is either the year before the IPO (year −1) or the IPO year (year 0) and T is either the year after the IPO (year +1) or two years after (year +2). Because an IPO can occur at any point between the $t = -1$ and $t = 0$ fiscal year ends and it is not clear how quickly the IPO could influence the private partner, we measure the change over both two-year time intervals. Fig. 2 illustrates the timing relationship between the IPO and measurement of the dependent variable.

Because of the flow of production, the impacts of a trading partner's IPO can manifest somewhat more quickly for suppliers than for customers. This is most clearly the case for AR and AP.

4.2. Multivariate models

The core specification in the multivariate analysis (shown for revenue in Eq. (1)) is the same for the revenue, PP&E, and cash models:

$$\Delta Revenue_{t,T} = \alpha + \beta_1 IPOFlag + \beta_2 Ln(Assets) + \beta_3 zROA + \beta_4 Qpredict + \frac{\beta_5 CashFlow}{Assets} + \beta_6 Lag\Delta Revenue_{t-2,t} \quad (1)$$

In Eq. (1), the left-hand variable is the geometric average annual percentage change in revenue over the same two-year intervals as defined above. In other tests, we replace $\Delta Revenue$ with $\Delta PP\&E$, or $\Delta Cash$, measured analogously. In models for ΔAR and $\Delta Loans$, we replace the lagged change in revenue with the contemporaneous change in revenue, as shown in Eq. (2):

[14] Private firms are classified under categories assigned by Teikoku Databank. We convert the Teikoku codes to Nikki Middle Industry codes using the conversion structure of Hamao et al. (2012).

[15] Several industries do not appear as suppliers or customers of IPO firms. These include: Fish and Marine Products, Sea Transportation, and Air Transportation.

Table 4
Industry distributions of private firms and IPO firms.

	Industry of IPO firms	1	3	5	7	9	11	13	15	17	19	21	23	27	29	31	33	35	37	41	43	45	47	49	51	52	53	55	57	59	63	65	67	69	71	Total	Pct	Same industry	
Industry of SME firms																																						No.	Pct.
1	Foods	34			10						1		3				1				50	25												8	132	3.1%	34	25.76%
3	Textile Products	2	1		3				2		2		1								33	17						2							63	1.5%	1	1.59%
5	Pulp & Paper	6	1	1	9		1		1		5		2				8			5	22	16					2	1	1		1			58	140	3.3%	1	0.71%
7	Chemicals	8			19	3					2	1		1			1		4	2	11	2												1	55	1.3%	19	34.55%
9	Drugs	2			2	12			1								8				42													2	69	1.6%	12	17.39%
11	Petroleum				1				1											1	2															5	0.1%		
13	Rubber Products											1	1			1					4	1						1							9	0.2%		
15	Ceramic			2	3				4		3									8	11							6						1	38	0.9%	4	10.53%
17	Iron and Steel				1						2	1		2							24							1		1				1	33	0.8%		
19	Non-ferrous Metal & Products	3	1		3						21	12	9	4	2	1	2			4	61					1	13					1		6	144	3.3%	21	14.58%
21	Machinery	6			6			1	3		7	18	18	4	1	2	1			12	50	4					6							7	146	3.4%	18	12.33%
23	Electrical	1			2				2		4	7	43	1		3	1			12	85	4					10				7			12	194	4.5%	43	22.16%
25	Shipbuilding & Repairing																1			4	2													1	8	0.2%		
27	Motor Vehicles & Parts							3		1	1	1	1	2						1	7	2				1								2	22	0.5%	2	9.09%
29	Transportation Equipment																			2	1							3			1				7	0.2%		
31	Precision Equipment	1											7		1	2	2			2	14	5												1	35	0.8%	2	5.71%
33	Other Manufacturing			1	8						6	5	4			1	3			6	40	6						3			1			18	102	2.4%	3	2.94%
35	Fish & Marine Products																																						
37	Mining			1															1	2	1								1						6	0.1%	1	16.67%
41	Construction	11	1		3				20	3	38	13	6	3	1		4			129	128	38					22	65			1	14	3	3	66	572	13.3%	129	22.55%
43	Wholesale Trade	47	8	6	76	9	1	2	6	5	63	25	70	8	3	15	31			68	302	162				11	8	23	1			29		1	127	1107	25.7%	302	27.28%
45	RetailTrade	16	1			4			1		6	1	3			1	1			1	104	19				3		4			8			15	188	4.4%	19	10.11%
47	Banks																																						
49	Securities																																						
51	Insurance																																						
52	Credit & Leasing																																						
53	Real Estate																																						
55	Railroad Transport																																						
57	Trucking	8			6	1					2	2	1	1			2		1		7	5			1	3		8	2	7	5	4			2	68	1.6%	2	2.94%
59	Sea Transport																																						
63	Warehousing	3			2				2		1	2	2				2			4	1	2						8		4	7	2			6	48	1.1%	7	14.58%
65	Communication Services																			2	1							1				10			3	17	0.4%	10	58.82%
67	Utilitites - Electrical																																						
69	Utilities - Gas																																						
71	Services	19			4				2		6	16	32			6	25	1		24	92	37	2	1	2	17	10	25	1		1	161	1		613	1098	25.5%	613	55.83%
Total		167	13	11	158	29	2	6	45	9	170	105	203	26	8	32	93	1	6	289	1095	345	2	1	3	35	43	180	5	13	15	237	5	4	950	4306	100.0%	1243	28.89%
Private Firm Percent		3.9%	0.3%	0.3%	3.7%	0.7%	0.0%	0.1%	1.0%	0.2%	3.9%	2.4%	4.7%	0.6%	0.2%	0.7%	2.2%	0.0%	0.1%	6.7%	25.4%	8.0%	0.0%	0.0%	0.1%	0.8%	1.0%	4.2%	0.1%	0.3%	0.3%	5.5%	0.1%	0.1%	22.1%	100.0%		28.9%	

The table reports the distributions of the industry linkages for IPO firms and their private supply-chain suppliers or customers. Each row shows the industry classification of the private firm and each column shows the industry of the linked IPO firm. The classification of the industry is based on the nikkei middle industry classifications.

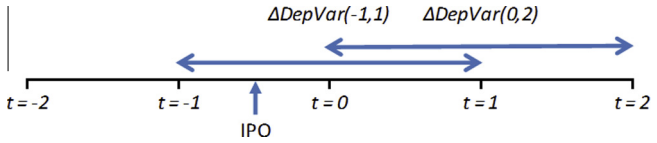

Figure 2. Measurement interval of dependent variables relative to IPO timing. Year 0 is defined as the fiscal year of the private firm during which the IPO of the supply-chain partner occurs. Date, $t = 0$ is the year 0 fiscal year end date. Dependent variable changes are measured over two-year intervals from $t = -1$ to $t = 1$ and from $t = 0$ to $t = 2$.

$$\Delta Revenue_{t,T} = \alpha + \beta_1 IPO\,Flag + \beta_2 Ln(Assets) + \beta_3 zROA + \beta_4 Q\,predict + \frac{\beta_5 CashFlow}{Assets} + \beta_6 \Delta Revenue_{t,T} \quad (2)$$

This specification is based on the expectation that AR will be determined partly by revenue growth, and that loans may substitute for trade credit. For ΔAP, we also replace revenue growth in Eq. (2) with growth in cost of goods sold (CGS) since CGS is more directly associated with AP.

In addition to studying the full sample, we examine subsamples where we exclude firms with zero balances for AR or AP in any year, and where comparison or matched firms are excluded if they had supply-chain relationships to IPO firms within three years of the IPO year. Firms with zero balances can be unusual in that they may not rely on trade credit as a regular practice. Often, these firms are in industries where trade credit is not typical. For example, retailers sometimes do not report AR and construction firms often do not have traditional AP balances. Results based on these subsamples are discussed below as robustness checks but are not reported.[16]

4.3. Independent variables

IPO Flag, the main explanatory variable of interest in the multivariate analysis, is a binary variable that is equal to 1 if the private firm's partner went public during the private firm's accounting period ending at $t = 0$; and is equal to 0 otherwise. If the effects of the IPO propagate through the supply chain in the ways hypothesized, the expected coefficient on *IPO Flag*, β_1, is positive, indicating higher growth rates for linked than for comparison or matched firms. The one exception is where the private firm is a supplier and growth of AR is the dependent variable. If the IPO firm provides liquidity to the supplier by paying more promptly than other firms, β_1 is expected to be negative.

As an alternative, we use *Pct. Primary*, calculated as the fraction of IPO shares that are primary as opposed to secondary (i.e. offered by existing shareholders). Conventionally, IPOs in Japan include high secondary percentages. Only primary shares generate cash for the issuer.

In each empirical model, we include controls for firm size, profitability, growth opportunities, liquidity, and prior or contemporaneous revenue or CGS growth. We also include industry and year fixed effects.

Because percentage growth rates tend to be higher for smaller firms, we control for firm size. Total assets, *Ln(Assets)*, is the natural logarithm of the private firm's total assets, measured as of fiscal year −1 so that the value is not affected by the partner's IPO. Firm size also indirectly controls for the importance of the private firm to the IPO firm since larger private firms are more likely to be important to the trading partner.

Firms that are more profitable are expected to grow more rapidly. To control for profitability, ROA is defined as operating income in year −1 divided by beginning total assets (i.e. at the end of year −2). In the empirical analysis, ROA is standardized to reflect the relative profitability in the firm's fiscal year/industry. Specifically, *zROA* is the private firm's ROA, minus the industry median for the year, divided by the industry standard deviation.[17]

Firms with more valuable investment opportunities are expected to grow more rapidly. We use an estimate of Tobin's Q to control for the value of investment opportunities. Following Campello and Graham (2013), we estimate Q from public firm data by regressing market-to-book ratios on ROA, revenue growth, operating income, and leverage for each year/industry.[18] We fit the estimated parameters to the private firm data to predict Q (*Q predict*).

Cash flow is included as a measure of liquidity. *Cash Flow/Assets* is after-tax net profits plus depreciation, minus dividends, minus directors' bonuses, all divided by lagged assets.[19] Cash flow can be expected to be positively related to growth, but is correlated with ROA and is also affected by the firm's capital structure choice.

In the revenue, PP&E, and cash models, as a firm-specific control, we include the lagged value of revenue growth measured over the two years before the period over which the dependent variable is measured. The rationale, based on cited literature, is that IPOs are more likely over periods of rapid growth. By including the lag of revenue growth, we seek to deal with the concern that the IPO firm and its trading partners may have correlated growth rates and that IPOs may be endogenously associated with rapid growth. Including the lagged revenue variable helps to assess whether the IPO has a separate effect on the growth rates of these variables.

In models of AR, AP, and loan growth, we include contemporaneous revenue growth. The AR and AP growth rates, respectively, are expected to increase with increases in the rates of revenue and CGS growth. Private suppliers may benefit from the IPO if newly public firms that are growing rapidly transfer liquidity by accelerating payment to suppliers. Private customers may benefit if the newly public firms transfer liquidity to customers by greater forbearance on AR collection.

Inclusion of industry and year fixed effects helps to address the concern that the partner's IPO may be endogenous. The matching approach also addresses endogeneity since matching by industry and year controls for the potential that the IPO is caused by an industry-wide omitted factor. Moreover, inclusion of ROA as a matching criterion helps to assure that matched firms were performing similarly in the year prior to the partner's IPO, so that differences around the IPO are more likely to reflect IPO spillover effects.

There are extreme outliers for some variables. Since it is not always possible to distinguish between true outliers and data errors, we deal with them in two ways. In the reported results, we treat the upper and lower tails of the distributions as true outliers and Winsorize at the 1% level. As a robustness check, we treat the 1% tails as data errors and drop the observations. Results are similar, and we discuss, but do not report, the results with dropped observations.

Descriptive statistics for private firms that are linked to IPO firms and for comparison and matched firms are shown in Table 5. Panel A shows statistics for private suppliers and for comparison and matched firms. Panel B shows similar statistics for private customers. The table is based on the set of observations that are usable

[16] An appendix summary of these and other robustness checks is available from the authors on request.

[17] Results are not materially different if *zROA* is replaced with unstandardized *ROA*.

[18] The financial data for public firms are collected from Nikkei NEEDs Financial Quest database. Stock price data are from Nikkei Portfolio Master.

[19] Results are not materially different if a narrower definition of cash flow (net profit plus depreciation expense) is used.

Table 5
Descriptive statistics for private firms and comparison firms.

	Suppliers of IPO firms				All comparison firms				Matched firms			
	Obs.	Mean	St. Dev.	Median	Obs.	Mean	St. Dev.	Median	Obs.	Mean	St. Dev.	Median
Panel A												
IPO Flag	1286	1.0	0.0	1.0	91333	0.0	0.0	0.0	1289	0.0	0.0	0.0
Pct. Primary	1286	0.5211	0.2634	0.5000	91333	0.0000	0.0000	0.0000	1289	0.0000	0.0000	0.0000
zROA	1286	0.0155	0.0711	0.0048	91333	0.0052	0.0561	−0.0009	1289	0.0122	0.0604	0.0022
Q predict	1286	5.974	16.972	1.359	91333	2.448	7.531	1.235	1289	5.246	15.947	1.356
Cash Flow/Assets	1286	0.0271	0.0718	0.0208	91333	0.0217	0.0572	0.0158	1289	0.0288	0.0578	0.0197
	Customers of IPO firms				All Comparison Firms				Matched Firms			
	Obs.	Mean	St. Dev.	Median	Obs.	Mean	St. Dev.	Median	Obs.	Mean	St. Dev.	Median
Panel B												
IPO Flag	1056	1.0	0.0	1.0	91563	0.0	0.0	0.0	1060	0.0	0.0	0.0
Pct. Primary	1056	0.6163	0.2344	0.5667	91563	0.0000	0.0000	0.0000	1060	0.0000	0.0000	0.0000
ln(Assets)	1056	15.003	1.356	14.955	91563	15.263	1.254	15.249	1060	15.389	1.637	15.118
zROA	1056	0.0128	0.0723	0.0021	91563	0.0053	0.0562	−0.0009	1060	0.0142	0.0627	0.0028
Q predict	1056	2.921	9.385	1.314	91563	2.492	7.731	1.236	1060	4.611	14.986	1.337
Cash Flow/Assets	1056	0.0282	0.0702	0.0207	91563	0.0217	0.0573	0.0158	1060	0.0297	0.0609	0.0198

The table shows summary statistics for private firms that are suppliers of IPO firms and private firms that are customers of IPO firms. Parallel summary statistics are reported for all private firms without linkages to IPO firms and for samples of private firms that are matched by industry, fiscal year, and firm size. *IPO Flag* is used to distinguish between linked private firms and comparison or matched private firms. *Pct. Primary* is the percentage of shares issued by the supply-chain partner that are primary shares. Year 0 is defined as the IPO year. *Ln(Assets)* is measured for the private firm as of the private firm's fiscal year end prior to the partner's IPO. *zROA* is ROA standardized as the difference between the private firm ROA and the median industry ROA divided by the within-industry-and-year standard deviation. *Q predict* is the estimate of Tobin's Q calculated based on an empirical model of Q for public firms. *Cash Flow/Assets* is operating profit plus depreciation in year -1, as a percentage of beginning assets. Observations in the upper and lower 1% tails of the distributions for *zROA, Q predict, and Cash Flow/Assets* are Winsorized.

in the multivariate analysis. The usable sample includes 1286 private suppliers of IPO firms and 1056 private customers.[20]

Based on either means or medians, linked firms are similar in size to comparison and matched firms, with similar standardized ROA, estimated Tobin's Q, and cash flow/assets. Converting from natural logs to yen, the median supplier has ¥3.79 billion in total assets (about $37.9 million) and the median customer has ¥3.12 billion. As noted, the sample includes a large fraction of firms that are considerably smaller. At one standard deviation below the means, supplier total assets are ¥922 million and customer total assets are ¥805 million. These statistics are similar for comparison and matched firms. Thus, the private firm samples include material fractions of SMEs.

5. Empirical results

5.1. Difference-in-difference tests

Table 6 presents the results of test of differences in growth rates of treatment and control firms for the five dependent variables in the analysis. As noted, because we are agnostic about the timing of IPO impacts, we measure the variables as changes over two different windows, years −1 to +1 and 0 to +2. Panel A presents statistics for suppliers to IPO firms and for comparison and matched firms, and Panel B presents statistics for customers. To test differences in percentage growth rates, the table includes *t*-test *p*-values of differences in means between linked private firms and comparison and matched firms and of Wilcoxon tests of differences in medians. Because the data are from a panel, *t*-tests are computed with standard errors clustered by firm.[21]

The tests in Panel A provide evidence on hypotheses 1a through 5a. Consistent with 1a and 2a, suppliers of IPO firms exhibit significantly higher mean growth rates of revenue and PP&E than do control firms. Depending on the specific comparison, the mean annual revenue growth rate for IPO firm partners is from about 1.6 to 3.1 percentage points higher than that of comparison or matched firms. PP&E growth rates are around 3.0 percentage points higher. Median growth rates are also significantly higher than for the comparison sample.

Relevant to 3a, the mean AR growth rates of private suppliers are positive and significantly higher than those of comparison firms. These results are contrary to what would be expected if IPO firms transfer liquidity by paying suppliers more quickly but, as noted, could be masked if suppliers routinely sell their AR to banks.

Under hypothesis 4a, private suppliers may be able to use relationships to IPO firms to gain greater access to bank loans. To the extent that suppliers engage in the practice of discounting AR to banks, results for AR and bank loan growth are expected to be weak and results for the growth of cash balances are expected to be strengthened. Consistent with these expectations, the higher growth rates of loans for suppliers of IPO firms relative to comparison is an indication that lenders respond to the IPO of an important customer by increased willingness to lend. Consistent with 5a, cash balance growth rates are significantly higher for linked firms than for control firms, with a growth rate difference of 4.6 percentage points or more.

As a robustness check and an alternative to examining the effects of the IPO on specific accounts that are related to liquidity, we apply the difference-in-difference method to the KZ Index of financial constraints and expect the change in the index to be more negative for private partners of IPO firms than for other private firms. This test is particularly relevant for suppliers due to the practice in Japan of discounting AR to banks. Not reported in the table, consistent with the spillover hypothesis, there is a statistically significant overall gain of liquidity for suppliers over the year −1 to +1 window.

Panel B shows similar difference-in-difference evidence for private customers and control firms. Here, again, consistent with 1b and 2b, the IPO is associated with significantly higher rates of private-partner revenue and PP&E growth. As implied by 3b, for

[20] Dropping outliers instead of Winsorizing (not reported) reduces sample sizes by 3 to 4%. Sample means and medians are similar to those reported.
[21] Significance levels without clustering are not materially different.

Table 6
Difference-in-difference tests between private firm partners of IPO firms and comparison and matched firms.

	Suppliers of IPO firms				Comparison firms				Difference in mean	Difference in median	Matched firms				Difference in mean	Difference in median
	Obs.	Mean	St. Dev.	Median	Obs.	Mean	St. Dev.	Median	*p*-Value	*p*-Value	Obs.	Mean	St. Dev.	Median	*p*-Value	*p*-Value
H-1a revenue																
Average annual change from −1 to +1	1286	0.0316	0.1683	0.0029	91333	0.0005	0.1394	−0.0102	0.000***	0.000***	1289	0.0158	0.1344	0.0022	0.010**	0.418
Average annual change from 0 to +2	1438	0.0324	0.1666	0.0042	90801	0.0059	0.1424	−0.0074	0.000***	0.000***	1423	0.0087	0.1316	−0.0008	0.021**	0.255
H-2a property, plant & equipment																
Average annual change from −1 to +1	1278	0.0644	0.3232	−0.0127	90716	0.0317	0.2721	−0.0152	0.000***	0.026**	1277	0.0322	0.2775	−0.0126	0.000***	0.441
Average annual change from 0 to +2	1431	0.0625	0.3271	−0.0102	90195	0.0323	0.2731	−0.0150	0.001***	0.004***	1410	0.0384	0.2769	−0.0124	0.039**	0.288
H-3a accounts receivable																
Average annual change from −1 to +1	1389	0.0513	0.2805	0.0190	82166	0.0205	0.3106	0.0057	0.000***	0.000***	1360	0.0405	0.3130	0.0165	0.355	0.276
Average annual change from 0 to +2	1260	0.0362	0.2824	0.0167	71646	0.0130	0.3048	0.0010	0.004***	0.000***	1206	0.0281	0.2800	0.0052	0.479	0.201
H-4a loans																
Average annual change from −1 to +1	1450	0.0307	0.3394	−0.0070	93732	0.0017	0.3033	−0.0168	0.001***	0.002***	1424	0.0070	0.3156	−0.0147	0.052*	0.078*
Average annual change from 0 to +2	1308	0.0187	0.3380	−0.0160	81616	−0.0068	0.3001	−0.0205	0.007***	0.050*	1271	0.0098	0.3204	−0.0179	0.497	0.635
H-5a cash																
Average annual change from −1 to +1	1286	0.1082	0.4313	0.0239	91289	0.0422	0.3735	−0.0033	0.000***	0.002***	1289	0.0442	0.3437	0.0024	0.000***	0.002***
Average annual change from 0 to +2	1438	0.0927	0.4038	0.0195	90759	0.0431	0.3755	−0.0029	0.000***	0.000***	1423	0.0464	0.3743	0.0055	0.002***	0.002***
	Customers of IPO firms				Comparison firms				Difference in mean	Difference in median	Matched firms				Difference in mean	Difference in median
	Obs.	Mean	St. Dev.	Median	Obs.	Mean	St. Dev.	Median	*p*-Value	*p*-Value	Obs.	Mean	St. Dev.	Median	*p*-Value	*p*-Value
H-1a revenue																
Average annual change from −1 to +1	1056	0.0359	0.1592	0.0109	91563	0.0006	0.1396	−0.0102	0.000***	0.000***	1060	0.0205	0.1336	0.0058	0.015**	0.135†
Average annual change from 0 to +2	1270	0.0259	0.1543	0.0028	90969	0.0010	0.1411	−0.0100	0.000***	0.000***	1207	0.0088	0.1315	−0.0010	0.004***	0.115†
H-2a property, plant & equipment																
Average annual change from −1 to +1	1051	0.0835	0.3714	−0.0097	90943	0.0315	0.2715	−0.0152	0.000***	0.000***	1057	0.0347	0.2788	−0.0136	0.001***	0.032**
Average annual change from 0 to +2	1264	0.0584	0.3269	−0.0124	90362	0.0324	0.2732	−0.0150	0.006***	0.014**	1201	0.0349	0.2663	−0.0117	0.054*	0.646
H-3a accounts payable																
Average annual change from −1 to +1	1080	0.0548	0.3779	0.0165	79730	0.0204	0.3382	0.0000	0.003***	0.001***	1064	0.0370	0.3335	0.0170	0.241	0.620
Average annual change from 0 to +2	1013	0.0520	0.3759	0.0045	69593	0.0127	0.3336	−0.0052	0.001***	0.062*	980	0.0096	0.3344	−0.0099	0.009***	0.078*
H-4a loans																
Average annual change from −1 to +1	1222	0.0323	0.3256	−0.0003	93960	0.0018	0.3036	−0.0168	0.001***	0.000***	1165	0.0042	0.3247	−0.0214	0.038**	0.027**
Average annual change from 0 to +2	1145	0.0238	0.3091	−0.0023	81779	−0.0068	0.3006	−0.0207	0.001***	0.000***	1065	0.0112	0.3116	−0.0147	0.341	0.134†
H-5a cash																
Average annual change from −1 to +1	1056	0.0909	0.4124	0.0162	91519	0.0425	0.3739	−0.0032	0.000***	0.000***	1060	0.0375	0.3689	0.0027	0.002***	0.009***
Average annual change from 0 to +2	1270	0.0843	0.4008	0.0177	90927	0.0433	0.3756	−0.0028	0.000***	0.000***	1207	0.0407	0.3657	0.0010	0.004***	0.008***

The table shows annualized geometric averages of percentage changes in Revenue, PP&E, Accounts Receivable (for Suppliers), Accounts Payable (for Customers), Loans, and Cash around the IPOs of supply-chain partners. Year 0 is defined as the IPO year. The sample is Winsorized from above and below at the 1% level. Mean *p*-values are based on t-tests of differences with clustering by firm. Median *p*-values are based on Wilcoxon tests. Significance levels are at the 1% (***), 5% (**), and 10% (*) levels in two-tail tests and 10% (†) in one-tail tests.

private customers, AP grow significantly more rapidly than for comparison firms, especially over the later (0 to +2) window. Moreover, AP growth rates are similar to or higher than revenue growth rates for all groups. The evidence, which is consistent in findings with outliers dropped (not reported), indicates that IPO firm liquidity is transmitted through forbearance or relaxation of payment terms. As implied by 4b and 5b, loan and cash growth rates are significantly higher for customers of IPO firms than for control firms. The evidence is consistent with private customers benefitting from their relationships with IPO firms. The overall liquidity results of the KZ index (not reported) also are significant in the expected direction during the 0 to +2 window.

Overall, the difference-in-difference method indicates that supply-chain relationships are important for entrepreneurial firms. The impacts of IPOs are different for suppliers than for customers. For suppliers, the main effects are on growth of revenue and PP&E, with ambiguous effects on AR growth and positive effects on cash and loan growth. For customers, the effects on revenue and PP&E are similarly positive, and the effects on AP, cash, and loan growth are positive.

5.2. Multivariate estimates

As a second method for evaluating the hypotheses, we use a multivariate approach to estimate the real spillover effects on growth rates of private suppliers' revenue and PP&E, and transmission through AR, loans and cash balances. We then do the same for private customers, except focusing on AP. To test the implications of the IPO spillover hypotheses, we focus on the coefficients on *IPO Flag* and *Pct. Primary* in models where the estimates are based on (1) the entire sample of linked suppliers (customers) and comparison firms, and (2) linked suppliers (customers) and matched firms. To control for IPO timing and for industry-wide factors, all models are estimated with year and industry fixed effects, with clustering by firm.

5.3. Spillover effects of IPOs on private suppliers

Table 7 reports the results for suppliers. Models (1) through (4) test differences between linked firms and comparison firms, first using *IPO Flag* and second using *Pct. Primary*. Models (5) through (8) test differences between linked firms and matched firms. Panel A shows estimates for revenue growth. The results, which are strongest over the −1 to +1 window, comport with hypothesis 1a, that IPOs of important customers are transmitted to suppliers and give rise to higher rates of revenue growth. Based on *IPO Flag*, over the −1 to +1 window, suppliers experience growth rates that are approximately 0.9–1.8 percentage points per year higher than do comparison or matched firms.

When *IPO Flag* is replaced with *Pct. Primary*, the coefficient estimates over the −1 to +1 widow increase to a range of 2.2–3.5 percentage points. The approximate doubling of magnitudes between *IPO Flag* and *Pct. Primary* is in line with the normal percentages of primary shares in Japanese IPOs – typically, around 50% of the IPO shares are primary.

As noted, we control for industry and year and include lagged revenue growth, and, in the matched sample we match by industry, year, and size. Thus, it appears that the significant coefficients on *IPO Flag* or *Pct. Primary* cannot be ascribed to failure to take account of the possible endogeneity of the trading partner's IPO. The other control variables indicate that revenue growth is lower for larger firms, generally higher for more profitable firms, positively related to the estimated value of growth options (*Q predict*) in the comparison sample, and positively related to the rate of revenue growth in the years before the IPO.

In Panel B, estimates of the relation between PP&E growth and a customer's IPO are statistically significant over the −1 to +1 window. Consistent with hypothesis 2a, PP&E growth is positively related to the IPO of an important customer. The partial effect of the IPO over the −1 to +1 window is a growth rate that is 1.1–1.9 percentage points higher than for comparison or matched firms (2.0–2.8 percentage points higher based on *Pct. Primary*). Because PP&E combines short- and long-term investments, the timing of impact of a customer's IPO is ambiguous. Hence, it is not surprising that the relationship is statistically weaker than for revenue growth. Similarly to the revenue results, PP&E growth rates are lower for larger firms, higher for more profitable firms, and higher for firms with histories of rapid revenue growth.

In Panels C, D, and E we examine possible pathways whereby a customer's IPO may be transmitted to a supplier. Panel C shows the results of regressing supplier AR on the partner's IPO variables and controls. If an IPO firm had been overly reliant on vendor financing, and if IPO proceeds were used to reduce reliance on the supplier, under hypothesis 3a we would expect signs on the IPO variables to be negative. However, if the IPO firm used IPO proceeds to accelerate its revenue growth, then any negative effect of reduced reliance on vendor financing would be partly offset by the effect of revenue growth on supplier AR.

We find no significant empirical support for the hypothesis that IPO firms act differently from others in their treatment of private suppliers. Results for the relation between supplier AR growth and the IPO are not statistically significant and the estimated coefficients are near zero. That is, controlling for other factors, AR growth rates of linked suppliers and control firms are similar. There are several possible explanations for the null finding. First, even if the IPO firm was paying more quickly after the IPO (as suggested be Fig. 1), the change would not be reflected in the supplier's AR balance if the supplier sold its receivables to banks. The evidence is consistent with the findings of Miwa and Ramseyer (2008) regarding the extensive use of AR discounting. Second, the finding suggests that IPO firms did not overly rely on trade credit from private suppliers. Use of IPO proceeds to reduce reliance on suppliers is most likely if an IPO firm was previously incurring significant costs due to over-reliance on trade credit. Since discount terms are rare in Japan, the financial incentive to accelerate payments is generally low. In fact, doing so could be costly since the firm would be forgoing zero-cost trade credit financing. Third, it is likely that well before going public, an IPO firm would be inclined to clean up its balance sheet, including by making sure that it was not incurring late payment penalties.

In Panel C, reduced reliance on trade creditors is indicated by a coefficient less than one on contemporaneous revenue growth. Thus, the evidence indicates that firms with high revenue growth rates tend to pay suppliers more quickly.

An alternative to faster collections of AR by the private supplier is greater reliance on financing from formal bank loans. As implied by hypothesis 4a, liquidity may be transmitted to suppliers if lenders regard the IPO as indicative of an improvement in private-firm credit quality. The evidence in Panel D provides no clear support for the hypothesis. The low significance could occur because selling AR to banks for cash is an off-balance-sheet transaction that substitutes for formal borrowing. With AR discounting, the contingent liability is not recorded as a loan and appears only as a higher cash balance offset by a lower level of AR. Also, suppliers can only be expected to increase borrowing if they were previously liquidity constrained and the IPO enhanced their ability to borrow.

Turning to the growth in cash balances, Panel E shows that, consistent with hypothesis 5a, cash balances of linked suppliers grow after the IPO at significantly faster rates than do those of comparison or matched firms. The differences in growth rates is significant over both windows and stronger in the −1 to +1 window, where

Table 7
Private suppliers of IPO firms.

	Private suppliers and comparison firms				Private suppliers and matched firms			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A								
H-1a revenue	−1 to +1	0 to +2	−1 to +1	0 to +2	−1 to +1	0 to +2	−1 to +1	0 to +2
IPO Flag	1.760***	0.656*			0.898†	0.494		
	(3.93)	(1.71)			(1.61)	(1.00)		
Pct. Primary			3.501***	1.676**			2.209**	1.334†
			(4.38)	(2.46)			(2.31)	(1.58)
ln (Assets)	−1.320***	−1.541***	−1.320***	−1.541***	−1.355***	−1.485***	−1.344***	−1.471***
	(−21.30)	(−24.04)	(−21.30)	(−24.03)	(−5.19)	(−7.09)	(−5.15)	(−7.01)
zROA	9.467***	11.985***	9.462***	11.979***	−9.631	4.645	−9.570	4.734†
	(4.49)	(5.91)	(4.49)	(5.91)	(−1.09)	(0.62)	(−1.08)	(0.63)
Q predict	0.042***	0.040***	0.043***	0.040***	0.015	−0.007	0.017	−0.007
	(5.60)	(5.33)	(5.74)	(5.39)	(0.74)	(−0.41)	(0.84)	(−0.37)
Cash Flow/Assets	−6.305***	−1.868	−6.302***	−1.865	0.133	3.572	0.337	3.577
	(−3.12)	(−0.93)	(−3.12)	(−0.93)	(0.01)	(0.49)	(0.04)	(0.49)
Revenue growth (−3 to −1)	0.064***		0.064***		0.085***		0.084***	
	(19.90)		(19.88)		(5.91)		(5.86)	
Revenue growth (−2 to 0)		0.060***		0.060***		0.082***		0.082***
		(17.80)		(17.79)		(6.27)		(6.24)
Constant	24.528***	25.958***	24.526***	25.939***	24.238***	25.430***	23.931***	25.084***
	(24.14)	(24.73)	(24.14)	(24.71)	(5.62)	(7.53)	(5.54)	(7.40)
Observations	92,619	92,239	92,619	92,239	2,575	2,861	2,575	2,861
Adj *R*-square	0.0992	0.102	0.0992	0.102	0.150	0.147	0.151	0.148
Panel B								
H-2a PP&E	−1 to +1	0 to +2	−1 to +1	0 to +2	−1 to +1	0 to +2	−1 to +1	0 to +2
IPO Flag	1.097†	1.053			1.921*	0.996		
	(1.30)	(1.23)			(1.71)	(0.91)		
Pct. Primary			1.999†	1.480			2.819†	1.159
			(1.37)	(1.02)			(1.57)	(0.68)
ln(Assets)	−2.480***	−2.669***	−2.480***	−2.669***	−1.983***	−2.567***	−1.996***	−2.573***
	(−18.81)	(−20.23)	(−18.82)	(−20.24)	(−4.18)	(−4.65)	(−4.22)	(−4.71)
zROA	37.583***	24.362***	37.583***	24.372***	12.700	15.694	13.052	15.898
	(8.46)	(5.56)	(8.46)	(5.56)	(0.59)	(0.74)	(0.61)	(0.75)
Q predict	0.000	0.010	0.001	0.010	−0.021	0.067†	−0.017	0.069†
	(0.02)	(0.64)	(0.07)	(0.68)	(−0.60)	(1.33)	(−0.48)	(1.37)
Cash Flow/Assets	19.365***	18.234***	19.363***	18.222***	41.620*	35.033*	41.506*	34.851*
	(5.15)	(4.69)	(5.15)	(4.68)	(1.92)	(1.88)	(1.92)	(1.87)
Revenue growth (−3 to −1)	0.112***		0.112***		0.149***		0.148***	
	(18.80)		(18.79)		(5.23)		(5.21)	
Revenue growth (−2 to 0)		0.124***		0.124***		0.158***		0.158***
		(20.05)		(20.05)		(5.00)		(5.00)
Constant	42.415***	44.658***	42.419***	44.669***	28.583***	39.419***	29.021***	39.716***
	(20.10)	(21.12)	(20.11)	(21.15)	(3.80)	(4.47)	(3.88)	(4.58)
Observations	91,994	91,626	91,994	91,626	2,555	2,841	2,555	2,841
Adj *R*-square	0.0667	0.0662	0.0667	0.0662	0.0988	0.0860	0.0986	0.0859
Panel C								
H-3a accts. receivable	−1 to +1	0 to +2	−1 to +1	0 to +2	−1 to +1	0 to +2	−1 to +1	0 to +2
IPO Flag	0.401	0.408			−0.478	−0.735		
		(0.59)			(−0.47)	(−0.73)		
Pct. Primary			0.968	−0.190			−0.134	−1.802
			(0.89)	(−0.16)			(−0.09)	(−1.13)
ln(Assets)	−0.841***	−0.615***	−0.841***	−0.615***	−1.072***	−0.645†	−1.057**	−0.659†
	(−7.87)	(−5.71)	(−7.86)	(−5.72)	(−2.60)	(−1.56)	(−2.57)	(−1.60)
zROA	8.255**	16.450***	8.250**	16.477***	4.566	5.392	4.360	5.302
	(2.15)	(4.34)	(2.15)	(4.35)	(0.31)	(0.42)	(0.30)	(0.42)
Q predict	−0.017	−0.025†	−0.017	−0.025†	0.014	0.046	0.013	0.044
	(−1.04)	(−1.47)	(−1.03)	(−1.45)	(0.45)	(1.13)	(0.42)	(1.08)
Cash Flow/Assets	−0.739	−6.047†	−0.740	−6.069†	−0.949	−1.213	−0.736	−1.181
	(−0.20)	(−1.60)	(−0.20)	(−1.60)	(−0.07)	(−0.09)	(−0.05)	(−0.09)
Revenue growth (−1 to +1)	0.919***		0.919***		0.966***		0.966***	
	(61.16)		(61.16)		(13.94)		(13.93)	
Revenue growth (0 to +2)		0.918***		0.918***		0.868***		0.869***
		(56.31)		(56.31)		(10.67)		(10.68)
Constant	16.437***	11.238***	16.430***	11.272***	20.832***	10.529†	20.382***	10.863*
	(9.67)	(6.51)	(9.67)	(6.53)	(3.08)	(1.59)	(3.04)	(1.65)
Observations	83,555	72,906	83,555	72,906	2,749	2,466	2,749	2,466
Adj *R*-square	0.205	0.198	0.205	0.198	0.263	0.217	0.263	0.217
Panel D								
H-4a loans	−1 to +1	0 to +2	−1 to +1	0 to +2	−1 to +1	0 to +2	−1 to +1	0 to +2
IPO Flag	0.466	0.819			0.748	−0.452		
	(0.55)	(0.89)			(0.63)	(−0.35)		

Table 7 (*continued*)

	Private suppliers and comparison firms				Private suppliers and matched firms			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Pct. Primary			1.884	1.283			2.268	−0.947
			(1.35)	(0.93)			(1.24)	(−0.52)
ln(Assets)	−3.201***	−3.202***	−3.199***	−3.202***	−2.312***	−2.839***	−2.284***	−2.845***
	(−26.56)	(−25.84)	(−26.56)	(−25.84)	(−5.24)	(−6.27)	(−5.21)	(−6.32)
zROA	24.360***	9.822**	24.339***	9.828**	18.486	−5.998	18.474	−6.066
	(5.63)	(2.26)	(5.62)	(2.26)	(1.00)	(−0.30)	(1.00)	(−0.30)
Q predict	0.013	0.040*	0.013	0.041*	−0.097	0.023	−0.096	0.022
	(0.64)	(1.89)	(0.64)	(1.91)	(−1.38)	(0.31)	(−1.37)	(0.31)
Cash Flow/Assets	4.597	−1.209	4.608	−1.212	6.635	7.040	6.781	7.016
	(1.19)	(−0.30)	(1.19)	(−0.30)	(0.38)	(0.36)	(0.39)	(0.36)
Revenue growth (−1 to +1)	0.384***		0.384***		0.496***		0.495***	
	(28.01)		(28.01)		(7.32)		(7.30)	
Revenue growth (0 to +2)		0.355***		0.355***		0.462***		0.462***
		(23.86)		(23.86)		(6.82)		(6.83)
Constant	51.661***	51.515***	51.621***	51.520***	39.363***	46.099***	38.675***	46.236***
	(26.26)	(25.64)	(26.25)	(25.65)	(5.44)	(6.26)	(5.41)	(6.34)
Observations	95,182	82,924	95,182	82,924	2,874	2,579	2,874	2,579
Adj *R*-square	0.0679	0.0582	0.0679	0.0582	0.0773	0.0635	0.0777	0.0635
Panel E								
H-5a cash	−1 to +1	0 to +2	−1 to +1	0 to +2	−1 to +1	0 to +2	−1 to +1	0 to +2
IPO Flag	4.016***	2.524**			5.183***	3.321**		
	(3.39)	(2.41)			(3.52)	(2.38)		
Pct. Primary			6.275***	5.069***			6.914***	6.146***
			(2.97)	(2.71)			(2.79)	(2.67)
ln(Assets)	−3.461***	−3.333***	−3.463***	−3.332***	−2.928***	−2.151***	−2.979***	−2.118***
	(−22.59)	(−22.16)	(−22.61)	(−22.16)	(−4.44)	(−3.42)	(−4.53)	(−3.37)
zROA	31.368***	24.198***	31.388***	24.199***	−27.944†	55.864**	−26.822	56.541**
	(6.69)	(5.09)	(6.69)	(5.09)	(−1.32)	(2.05)	(−1.26)	(2.07)
Q predict	0.079***	0.074***	0.081***	0.075***	0.031	0.026	0.042	0.032
	(3.81)	(3.54)	(3.93)	(3.61)	(0.54)	(0.47)	(0.73)	(0.58)
Cash Flow/Assets	8.108*	6.077	8.084*	6.068	54.032**	−26.088	53.486**	−26.442
	(1.81)	(1.26)	(1.80)	(1.25)	(2.29)	(−0.87)	(2.27)	(−0.88)
Revenue growth (−3 to −1)	0.116***		0.116***		0.131***		0.130***	
	(17.69)		(17.68)		(3.94)		(3.90)	
Revenue growth (−2 to 0)		0.125***		0.125***		0.146***		0.146***
		(18.83)		(18.82)		(4.56)		(4.54)
Constant	56.243***	53.005***	56.289***	52.981***	45.861***	29.254***	47.486***	28.752***
	(22.34)	(21.46)	(22.36)	(21.45)	(4.21)	(2.82)	(4.38)	(2.77)
Observations	92,575	92,197	92,575	92,197	2,575	2,861	2,575	2,861
Adj *R*-square	0.0474	0.0468	0.0473	0.0469	0.0721	0.0616	0.0708	0.0623

The table shows regression results for relations between private suppliers of IPOs firms and either comparison or matched private firms. Panel A shows the results for revenue growth, Panel B shows growth in PP&E, Panel C shows AR growth, Panels D shows loan growth, and Panel E show growth in cash. Year 0 is defined as the IPO year. Estimates are for the geometric averages of two-year periods, from year −1 to year +1 or year 0 and year +2. The first four models are based on the comparison-sample approach using data for linked private firms and all non-linked private firms. Models (5) through (8) are based on the matched-firm approach, where each linked private supplier is matched to a private firm that does not have a supply-chain partner that went public in the same year. All models include industry and year fixed effects. The sample data are Winsorized in the 1% tails of the distributions. Robust *t*-statistics clustered by firm are reported, along with significance levels at the 1% (***), 5% (**), and 10% (*) levels in two-tail tests and 10% (†) in one-tail tests.

the range is from 4.0 to 5.2 percentage points. As expected, the coefficients on *Pct. Primary* are about twice as high as those on *IPO Flag*. Suppliers are apparently able to accumulate cash more rapidly than either comparison or matched firms, possibly due to higher rates of revenue growth and sales of AR.

In summary, the IPO of an important customer is associated with economically and statistically significant spillover effects on private suppliers, especially over the years surrounding the IPO, from −1 to +1. We find significantly more rapid revenue and PP&E growth during this window. Evidence on transmission is less clear. We do not find evidence of a significant reduction in AR or a significant increase in formal borrowing, but there is significant evidence of growth in cash balances. The analysis of transmission is obscured in Japan by the practice of selling AR to banks for cash, a practice that is not quantified in the private firm data. Because transmission of liquidity can manifest in different ways, as a robustness test of improvement in overall liquidity, we regressed the KZ index on the same variables as in the Cash model (Panel E) and found statistically significant reductions in financial constraints over the −1 to +1 window.

5.4. Spillover effects of IPOs on private customers

Table 8 shows the findings for private customers of IPO firms. In Panel A, consistent with hypothesis 1b, we find a positive relation between the IPO and the customer's rate of revenue growth. Coefficients are significant over both windows and magnitudes and significance levels are similar to those for suppliers, 0.8–1.6 percentage points. After controlling for other factors including the private firm's prior revenue growth rate, industry, year, and other factors, suppliers and customers of IPO firms both achieve higher rates of revenue growth than do comparison or matched firms, which indicates that the IPO fosters growth of private firms both up and down the supply chain.

The growth rates of suppliers' PP&E are generally positively related to the IPO of an important customer, significantly so over the −1 to +1 interval. The results in Panel B for private customers are similarly significant to those for suppliers, indicative of comparable support for hypotheses 2b and 2a. The partial effect of the IPO is a PP&E growth rate over years −1 to +1 that is 2.3–3.2 percentage points higher per year than for comparison or matched firms.

Table 8
Private customers of IPO firms.

	Private customers and comparison firms				Private customers and matched firms			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A								
H-1b revenue	−1 to +1	0 to +2	−1 to +1	0 to +2	−1 to +1	0 to +2	−1 to +1	0 to +2
IPO Flag	1.626***	0.795*			0.759†	1.085**		
	(3.54)	(1.87)			(1.30)	(1.98)		
Pct. Primary			2.457***	1.447**			1.418†	1.954**
			(3.49)	(2.23)			(1.64)	(2.46)
ln(Assets)	−1.320***	−1.541***	−1.321***	−1.541***	−1.860***	−1.476***	−1.862***	−1.476***
	(−21.30)	(−24.03)	(−21.31)	(−24.03)	(−6.86)	(−5.94)	(−6.90)	(−5.95)
zROA	9.497***	11.993***	9.483***	11.984***	−6.699	6.884	−6.998	6.589
	(4.50)	(5.91)	(4.49)	(5.91)	(−0.51)	(0.65)	(−0.54)	(0.62)
Q predict	0.043***	0.040***	0.043***	0.040***	0.026	0.036	0.027	0.037†
	(5.81)	(5.41)	(5.84)	(5.42)	(1.09)	(1.58)	(1.13)	(1.64)
Cash Flow/Assets	−6.360***	−1.887	−6.350***	−1.885	−15.135	−6.803	−14.914	−6.693
	(−3.15)	(−0.94)	(−3.14)	(−0.94)	(−1.13)	(−0.60)	(−1.12)	(−0.59)
Revenue growth (−3 to −1)	0.064***		0.064***		0.075***		0.075***	
	(19.91)		(19.91)		(5.46)		(5.47)	
Revenue growth (−2 to 0)		0.060***		0.060***		0.074***		0.074***
		(17.80)		(17.80)		(5.22)		(5.24)
Constant	24.553***	25.957***	24.567***	25.955***	34.268***	23.259***	34.251***	23.181***
	(24.14)	(24.73)	(24.16)	(24.73)	(7.51)	(5.67)	(7.56)	(5.66)
Observations	92,619	92,239	92,619	92,239	2,116	2,477	2,116	2,477
Adj *R*-square	0.0991	0.102	0.0991	0.102	0.111	0.112	0.111	0.113
Panel B								
H-2b PP&E	−1 to +1	0 to +2	−1 to +1	0 to +2	−1 to +1	0 to +2	−1 to +1	0 to +2
IPO Flag	2.317**	−0.252			3.167**	1.204		
	(2.12)	(−0.27)			(2.36)	(1.02)		
Pct. Primary			2.840†	−0.753			3.635*	0.854
			(1.77)	(−0.58)			(1.87)	(0.52)
ln(Assets)	−2.478***	−2.671***	−2.479***	−2.671***	−3.855***	−2.307***	−3.912***	−2.335***
	(−18.81)	(−20.25)	(−18.82)	(−20.25)	(−6.34)	(−4.52)	(−6.38)	(−4.54)
zROA	37.574***	24.399***	37.566***	24.406***	46.708**	1.726	45.793**	1.623
	(8.46)	(5.57)	(8.45)	(5.57)	(2.12)	(0.07)	(2.08)	(0.07)
Q predict	0.001	0.011	0.001	0.011	−0.010	−0.007	−0.008	−0.007
	(0.08)	(0.70)	(0.10)	(0.70)	(−0.22)	(−0.17)	(−0.17)	(−0.17)
Cash Flow/Assets	19.331***	18.201***	19.342***	18.200***	14.243	52.569**	14.766	52.566**
	(5.15)	(4.68)	(5.15)	(4.68)	(0.65)	(2.41)	(0.67)	(2.41)
Revenue growth (−3 to −1)	0.112***		0.112***		0.102***		0.103***	
	(18.78)		(18.79)		(3.82)		(3.84)	
Revenue growth (−2 to 0)		0.124***		0.124***		0.124***		0.124***
		(20.05)		(20.05)		(4.38)		(4.39)
Constant	42.372***	44.731***	42.408***	44.740***	61.342***	36.029***	62.754***	36.826***
	(20.11)	(21.17)	(20.12)	(21.17)	(6.35)	(4.48)	(6.43)	(4.51)
Observations	91,994	91,626	91,994	91,626	2,108	2,465	2,108	2,465
Adj *R*-square	0.0667	0.0662	0.0667	0.0662	0.0751	0.0573	0.0742	0.0570
Panel C								
H-3b accts. payable	−1 to +1	0 to +2	−1 to +1	0 to +2	−1 to +1	0 to +2	−1 to +1	0 to +2
IPO Flag	−0.052	1.890*			0.353	2.827*		
	(−0.05)	(1.76)			(0.25)	(1.87)		
Pct. Primary			−0.308	1.958			−0.068	2.274
			(−0.20)	(1.21)			(−0.03)	(1.04)
ln(Assets)	−0.244*	0.201†	−0.244*	0.199†	−0.360	−0.757	−0.376	−0.821†
	(−1.90)	(1.55)	(−1.91)	(1.53)	(−0.58)	(−1.25)	(−0.61)	(−1.35)

Table 8 (*continued*)

	Private customers and comparison firms				Private customers and matched firms			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
zROA	−16.332***	7.316†	−16.326***	7.325†	5.906	25.261	6.059	25.446
	(−3.84)	(1.56)	(−3.84)	(1.56)	(0.24)	(0.85)	(0.25)	(0.85)
Q predict	−0.049***	−0.061***	−0.049***	−0.061***	0.025	−0.018	0.025	−0.017
	(−2.66)	(−3.27)	(−2.66)	(−3.26)	(0.53)	(−0.32)	(0.52)	(−0.30)
Cash Flow/Assets	−3.357	−8.435*	−3.360	−8.442*	−30.533	−22.546	−30.695	−22.909
	(−0.80)	(−1.92)	(−0.80)	(−1.92)	(−1.24)	(−0.71)	(−1.25)	(−0.72)
CGS growth (−1 to 1)	1.012***		1.012***		1.006***		1.006***	
	(59.43)		(59.42)		(11.08)		(11.07)	
CGS growth (0 to +2)		1.012***		1.012***		0.982***		0.983***
		(55.87)		(55.87)		(10.21)		(10.18)
Constant	9.427***	−0.391	9.433***	−0.346	11.655	11.945	12.142	13.741
	(4.58)	(−0.19)	(4.58)	(−0.17)	(1.12)	(1.11)	(1.18)	(1.28)
Observations	80,809	70,606	80,809	70,606	2,144	1,993	2,144	1,993
Adj *R*-square	0.174	0.171	0.174	0.171	0.171	0.153	0.171	0.152
Panel D								
H−4b loans	−1 to +1	0 to +2	−1 to +1	0 to +2	−1 to +1	0 to +2	−1 to +1	0 to +2
IPO Flag	−0.075	0.428			1.240	−0.643		
	(−0.08)	(0.48)			(0.93)	(−0.51)		
Pct. Primary			−0.858†	0.372			0.520	−1.241
			(−0.63)	(0.28)			(0.27)	(−0.70)
ln(Assets)	−3.202***	−3.203***	−3.202***	−3.203***	−3.176***	−3.500***	−3.216***	−3.501***
	(−26.57)	(−25.85)	(−26.58)	(−25.85)	(−6.12)	(−6.66)	(−6.23)	(−6.64)
zROA	24.380***	9.849**	24.394***	9.851**	19.747	11.534	19.726	11.693
	(5.63)	(2.26)	(5.63)	(2.26)	(0.66)	(0.52)	(0.66)	(0.53)
Q predict	0.014	0.041*	0.014	0.041*	0.118*	0.097	0.118*	0.096
	(0.65)	(1.91)	(0.65)	(1.91)	(1.70)	(1.19)	(1.71)	(1.18)
Cash Flow/Assets	4.587	−1.229	4.583	−1.229	7.944	12.117	7.893	12.038
	(1.19)	(−0.30)	(1.19)	(−0.30)	(0.28)	(0.59)	(0.28)	(0.58)
Revenue growth (−1 to 1)	0.385***		0.385***		0.359***		0.359***	
	(28.02)		(28.02)		(4.91)		(4.92)	
Revenue growth (0 to +2)		0.355***		0.355***		0.408***		0.408***
		(23.86)		(23.86)		(5.36)		(5.37)
Constant	51.694***	51.547***	51.713***	51.558***	44.477***	51.859***	45.601***	51.944***
	(26.29)	(25.67)	(26.31)	(25.67)	(5.07)	(6.05)	(5.24)	(6.03)
Observations	95,182	82,924	95,182	82,924	2,387	2,210	2,387	2,210
Adj *R*-square	0.0679	0.0582	0.0679	0.0582	0.0579	0.0710	0.0576	0.0711
Panel E								
H−5b Cash	−1 to +1	0 to +2	−1 to +1	0 to +2	−1 to +1	0 to +2	−1 to +1	0 to +2
IPO Flag	2.064†	1.779†			3.641**	2.913**		
	(1.64)	(1.63)			(2.25)	(2.00)		
Pct. Primary			3.080†	1.951			4.910**	2.724
			(1.57)	(1.19)			(1.98)	(1.27)
ln(Assets)	−3.465***	−3.333***	−3.466***	−3.334***	−3.828***	−3.624***	−3.877***	−3.679***
	(−22.60)	(−22.17)	(−22.61)	(−22.18)	(−4.82)	(−4.80)	(−4.89)	(−4.87)
zROA	31.468***	24.252***	31.450***	24.251***	−7.008	9.577	−8.166	9.255
	(6.71)	(5.10)	(6.70)	(5.10)	(−0.23)	(0.35)	(−0.27)	(0.34)
Q predict	0.082***	0.076***	0.082***	0.076***	−0.004	−0.053	−0.001	−0.052
	(3.98)	(3.64)	(3.99)	(3.65)	(−0.06)	(−0.75)	(−0.02)	(−0.74)
Cash Flow/Assets	7.980*	6.001	7.992*	6.002	2.485	−13.434	3.214	−13.425
	(1.78)	(1.24)	(1.78)	(1.24)	(0.08)	(−0.47)	(0.10)	(−0.47)
Revenue growth (−3 to −1)	0.116***		0.116***		0.143***		0.144***	
	(17.71)		(17.71)		(4.13)		(4.15)	

(*continued on next page*)

Table 8 (*continued*)

	Private customers and comparison firms				Private customers and matched firms			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Revenue growth (−2 to 0)		0.125***		0.125***		0.093***		0.094***
		(18.84)		(18.84)		(2.76)		(2.78)
Constant	56.376***	53.064***	56.395***	53.096***	55.238***	53.769***	56.405***	55.290***
	(22.38)	(21.50)	(22.39)	(21.51)	(4.09)	(4.63)	(4.19)	(4.75)
Observations	92,575	92,197	92,575	92,197	2,116	2,477	2,116	2,477
Adj R-square	0.0472	0.0468	0.0472	0.0468	0.0609	0.0539	0.0606	0.0531

The table shows regression results for relations between private suppliers of IPOs firms and either comparison or matched private firms. Panel A shows the results for revenue growth, Panel B shows growth in PP&E, Panel C shows AP growth, Panels D shows loan growth, and Panel E show growth in cash. Year 0 is defined as the IPO year. Estimates are for the geometric averages of two-year periods, from year −1 to year +1 or year 0 and year +2. The first four models are based on the comparison-sample approach using data for linked private firms and all non-linked private firms. Models (5) through (8) are based on the matched-firm approach, where each linked private supplier is matched to a private firm that does not have a supply-chain partner that went public in the same year. All models include industry and year fixed effects. The sample data are Winsorized in the 1% tails of the distributions. Robust t-statistics clustered by firm are reported, along with significance levels at the 1% (***), 5% (**), and 10% (*) levels in two-tail tests and 10% (†) in one-tail tests.

Panel C examines the relation between private customer AP and the supplier's IPO. The relation is significantly positive relative to comparison or matched firms over the year 0 to +2 interval. In contrast to AR, the AP results are less affected by the practice of selling AR. In particular, the extent to which IPO firms sell their receivables to banks would reduce the likelihood of forbearance reflected in growth of customer AP. The result in Panel C, though somewhat weak and concentrated in the 0 to +2 window, is consistent with hypothesis 3b concerning the IPO firm's augmentation of trade credit by increasing forbearance of collections in the years after the IPO and with the change in net trade credit of IPO firms shown in Fig. 1. The evidence suggests that IPO proceeds are used, in part, to support customers by transferring liquidity to them after the IPO.

In addition to the differentially higher growth rates for customers of IPO firms, Panel C also shows, controlling for other factors, that AP growth rates are comparable to revenue growth rates in that the coefficients on contemporaneous CGS growth are not significantly different from one. This is in contrast to the results for private suppliers, where, controlling for other factors, AR growth was less than revenue growth.

In Panel D we find no significant evidence that the IPO of an important supplier is associated with a higher rate of loan growth for customers. However, we cannot conclude that lenders do not view the IPO as an indication of the customer's credit quality. For borrowing to increase, customers must be motivated to borrow. Since, from Panel C, vendor financing increases in proportion to revenue growth, it is not apparent that customers would face an increased need for loans.

As implied by hypothesis 5b, in Panel E, the relation between the IPO of an important supplier and the growth rate of cash balances of customers is positive. The relationship, though statistically significant in most models, is generally weaker and less economically significant than for private suppliers, consistent with the differential impact of discounting AR on suppliers versus customers. Here again, for robustness, regression of the KZ index on the same variables as in Panel E yields significantly negative coefficients, consistent with the hypothesis that the IPO of a supplier leads to improved liquidity for private customers.

Overall, the evidence for private customers is indicative of economically important spillover effects in the form of higher rates of revenue growth, and, to a lesser extent, PP&E growth. Liquidity appears to be transmitted partly through relationships by way of more generous trade credit with positive financial spillover effects on cash balances but not on formal borrowing.

5.5. Additional robustness tests

Some firms do not offer or do not provide trade credit, and their inclusion could bias the results. As there is no direct indication of whether a firm offers or uses trade credit or whether their policies change over time, we tested this issue by dropping supplier observations where any value of AR was zero and customer observations where any value of AP was zero. This resulted in dropping about 5% of the observations in the AR and AP models. Results were substantially the same as those reported in Tables 7 and 8.

In most of the industries listed in Table 4 the median balances of AR and AP were equivalent to around 30–60 days of revenue and CGS, respectively. Some industries had very low levels of AR or AP, indicating that trade credit was not typical in those industries or was not a major financing vehicle. Accordingly, for the AR and AP growth models, we tried dropping those industries. For suppliers we dropped Construction, Warehousing, and Trucking and for customers we dropped those three and also Retailing. Dropping the industries reduced the comparison firm

sample in the supplier models by about 20% on average and reduced the matched samples and subject samples by about 10%. The analogous reductions in the customer models were both about 15% on average. Dropping these industries does not materially affect the results.

In Tables 7 and 8 the comparison and matched firm samples exclude firms with supply-chain partners that went public in the same year. However, they do include firms with partners that went public within a few years of the subject year. We tested sensitivity to this inclusion rule by dropping comparison and matched firms with trading partners that went public within three years of the subject year. The more restrictive rule had a modest impact, reducing the samples of comparison and matched firms by about 5% on average. The coefficient estimates on *IPO Flag* and *Pct. Primary* were not materially different from those reported.

The hypothesis that private firms may benefit from the IPOs of important supply-chain partners is, perhaps, more compelling for smaller private firms. Conversely, it may be that very small firms are not important enough to warrant the IPO firm's attention. To test whether spillover effects are stronger for smaller firms, we tried adding the interaction of *ln(Assets)* and *IPO Flag* or *Pct. Primary* to the models reported in Tables 7 and 8. Results were generally consistent with the view that the spillover effects are greater for smaller firms, though most results are weak. Small suppliers have higher rates of revenue growth and higher rates of PP&E growth; the AR and cash growth rates are not significantly different than those reported; and there is some evidence that the growth rate of loans may be greater for larger private firms. Results for customers of IPO firms are similar but stronger. Small customers have higher rates of revenue, PP&E, and cash growth, and also higher rates of AP growth. Our conclusion is that the spillover effects are stronger for smaller firms, particularly for smaller customers of IPO firms.

Finally, as an alternative to testing whether the AP and AR growth rates are significantly related to the partner's IPO, we tried using ratios of AR/Revenue and AP/CGS as dependent variables. Because it is unclear whether the changes should be measured as percentage changes over time or as differences over time, and because there is substantial mean reversion in these ratios, we used the ending value of the ratio as a dependent variable and included the beginning value as an independent variable, and we tried to control for mean reversion by including the revenue growth rate. However, this specification led to coefficients on beginning values of AR/Revenue and AP/CGS that were much lower than expected, consistent with mean reversion in the ratios, which gives rise to problems interpreting the coefficients on *IPO Flag*. Because our general focus is on growth rates and because of the inherent difficulties of interpreting changes in ratios, our conclusions are based on the specifications reported in Tables 6–8.

6. Conclusions and discussion

Private firms, including entrepreneurial enterprises, are important drivers of innovation and economic growth. Yet these firms can be dependent on supplier and customer relationships for their success. They are particularly dependent on vendor financing and are often compelled by competition to provide financing to their own customers. When alternative financing sources are unavailable or are difficult to access, supply-chain relationships can create bottlenecks that impact firms up and down the supply chain. Conversely, if a firm in the chain is able to tap into alternative financing sources, the improved liquidity of that firm can benefit firms throughout the supply chain. Suppliers may benefit from reduced need to provide trade credit and customers may benefit from access to more generous effective trade credit terms. Even if private suppliers and customers have adequate access to financing, if the IPO leads to an expectation of sustained higher revenue for suppliers and customers, the IPO can positively influence investments in real assets by the private firms. The transmission of liquidity from an IPO of a firm in the supply chain can be reflected in higher cash balances of private partners. Also, if the IPO is seen by creditors as an indication of the quality of the partner firm, it may increase the firm's access to bank financing.

Our evidence indicates that IPO growth and liquidity are transmitted along the supply chain. For both suppliers and customers, IPOs of trading partners are associated with higher growth rates of revenue, fixed asset investment, and cash balances. The transmission mechanism varies for suppliers and customers. While in some environments, newly public firms could transmit liquidity to their suppliers by paying more quickly, we do not find significant evidence of this in our sample of private firms in Japan. Because, in Japan, accounts receivables tend to be discounted (effectively sold to banks), we do not observe significant balance sheet changes in suppliers' receivables surrounding the partner's IPO but, instead, find significant increases in cash balances. Although discounting of receivables works against finding evidence of forbearance in collections, we do find some evidence that IPO firms are more flexible with customers who experience increases in growth of accounts payable balances after the IPO. In countries like Japan where the institutions like factoring and bank discounting and are common, we would expect to see similar results. In countries where it is more common to rely on formal lending arrangements such as the collateralization of accounts receivable to secure bank loans, the effects on receivables balances could be less muted, but other results regarding spillovers in the form of increased growth in revenue, PP&E, cash balances and reduced liquidity constraints would be similar.

The results have important implications for entrepreneurs and managers of entrepreneurial firms. Developing relationships with strong suppliers and customers can enhance performance. The findings also have implications for public policy in support of entrepreneurship. In many countries, IPOs are viewed as tools for boosting the economy by growing public firms. The evidence in this study indicates that IPOs also facilitate growth of their private supply-chain partners, which has the potential to benefit the broader economy. Moreover, private firms with public supply-chain partners may not need to access public equity markets directly, especially when the benefits of public market access flow through to private partners.

Our study points to other avenues for further research. An unanswered question is whether the IPO spillover effects result in overall economic growth or come at the expense of competitors that lose out when their rivals gain through the IPOs of supply-chain partners. Another question is whether supply-chain relationships with public firms have positive effects on the innovative activity of private firms. The added liquidity associated with an IPO may reduce capital constraints on private partners in ways that enable the firms to devote more resources to innovation.

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