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Abstract

The relationship between the production process and short-term credit is well established in the literature. Here we argue that the stage of fabrication of inventories can affect the incentives to offer and take up trade credit, an important source of short-term credit for businesses. Using a panel of over half a million observations for French firms across several sectors, we find evidence that trade credit is enhanced through processing of goods by the seller, as goods become specialized. But we also find that as buyers process goods the sellers' incentives to extend trade credit diminishes. In short, once production takes place there is no going back.

Keywords: short-term credit, trade credit, inventories

JEL classification: D22, G31, G32

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1 Introduction

The relationship between the production process and short-term credit is well established in the literature. Here we focus on trade credit, the short-term finance accompanying the transfer of goods from supplier to buyer until payment is settled.[1] The recent trade credit literature argues that firms offer trade credit to manage inventories and that more trade credit is used when the transacted goods are specialized. In this paper we explore the incentives that the stage of fabrication of inventories creates for the offer and receipt of trade credit. The key observation we make is that inventories are more dedicated to their owner once they are processed. In industries where a large proportion of inventories are held in unprocessed form they are more vulnerable to diversion than in industries where a large proportion are processed, altering the incentives for firms to offer and receive trade credit. In addition, there is a greater incentive for an upstream firm to sell its goods - on trade credit if necessary - once its own inventories have been transformed in the production process. Finally, once goods are processed by the recipient they have less value to the upstream seller if seized for non-payment, creating a disincentive for sellers to offer trade credit to downstream firms with large proportions of processed inventories. In other words, the advantages sellers have over banks in handling seized collateral diminish once goods are processed. This means for three different - and often contrary - reasons, there is no going back to suppliers further upstream once goods have been processed to some degree.

Our paper is connected to three strands in the trade credit literature. First, Burkart and Ellingsen (2004), Cuñat (2007), and Fabbri and Menichini (2010), demonstrate that specialized products tie customers and suppliers more closely together since there are fewer alternative uses for a specialized good (minimizing the incentives of a customer to divert the input) and fewer alternative suppliers. Second, Emery (1987), Bougheas et al. (2009), and Daripa and Nilsen (2011), propose that there are incentives for suppliers to subsidize the sale of goods to customers in order to minimize their own inventory holding costs. Third, Petersen and Rajan (1997), Longhofer and Santos (2003), and Frank and Maksimovic (2005) argue that suppliers may have advantages over banks in disposing of assets seized if the customer

[1] To avoid any confusion regarding the object of this study, note that *trade credit* has a clear definition in accounting and a looser one in finance. In particular, whenever a firm receives an order for goods or services that will be paid later, it records a "trade credit" on the accounts receivable section of its balance sheet. This is true regardless of whether the purchaser is foreign or domestic, so that firms with a lot of trade credit on their books may not do any international trade. In finance, trade credit is also sometimes used to refer to working-capital loans used to finance international trade credits on the balance sheets of exporters (*trade finance*). Our analysis refers to trade credit in the accounting sense.

does not pay for them (collateral liquidation advantages), because goods that have not been paid for can be resold through their sales network, providing suppliers with higher recovery values of seized goods and better protection from ex-post hold-up problems. This is closely connected to what Almeida and Campello (2007), Campello and Giambona (2011) and Campello and Hackbarth (2012) refer to as the saleability or tangibility of assets, providing a means to relax constraints for firms seeking external finance for fixed capital investment. This issue in our context raises ex-ante short-term credit capacity for downstream firms and may create incentives for firms to seek finance from suppliers rather than banks.

We argue that the stage of fabrication of inventories has a bearing on the diversion, inventory management and collateral liquidation theories. First, the diversion theory acknowledges that the degree of specialization can positively affect the willingness of firms to offer trade credit, but while there is some inherent specialization in the goods of different industries, goods become more specialized as they go through the production process, e.g. raw materials are turned into work in progress and ultimately final goods. In downstream industries where a large proportion of inventories are held in unprocessed form they are more vulnerable to diversion than in industries where a large proportion are processed. Second, the inventory management theory, recognizes the incentives to minimize inventory, but this should be modified to acknowledge that finished goods held by the upstream firm are more readily sold (using trade credit as an incentive mechanism) than raw materials or work in progress. Indeed there is an incentive to offer trade credit to facilitate sales and reduce inventories of finished goods. Once again the proportions of inventories that are held at different stages of fabrication is important. Finally, the advantages that upstream firms have over banks in collateral liquidation theories are influenced by the fact that goods are processed. We reaffirm that this feature, noted by Petersen and Rajan (1997), is connected to the extent to which goods are processed after purchase.

We make use of a specialized dataset with information on the disaggregation of inventories at the level of the firm. Using a panel of around 82,000 French firms in several economic sectors, our paper exploits the information on inventories at different stages of fabrication (raw materials, work in progress, semi-finished and finished goods, and goods for sale) to consider the effect on trade credit extended as inventories are processed from raw material form to work in progress, semi-finished and finished goods.

First, we find that trade credit offered (relative to sales) and the upstream inventory holding (relative to sales) are negatively correlated as firms simultaneously decide their credit

sales and their stocks of inventories, and the impact is stronger in the case of processed inventories. As more work is done to the inputs, they are more dedicated to the owner; inventories of specialized goods have fewer diversion opportunities at every stage of production, therefore the upstream firm has greater incentive to obtain sales, and trade credit provides the inducement to the customer to purchase inventory.

Second, we examine the impact of the stage of fabrication of inventories on the trade credit offered by different size classes of firms in sectors such as manufacturing, construction, and retailing. Our results suggest a greater sensitivity of trade credit extended to processed inventories compared to total inventories for smaller firms than for larger firms supporting trade credit theories by Bougheas et al. (2009) and Daripa and Nilsen (2011).

Third, we analyse the uptake of trade credit and find that firms that purchase a higher proportion of differentiated inputs buy more on credit from their suppliers, i.e. they have more trade credit received than other firms. This is a confirmation of our first finding that producers of specialized goods have a higher incentive to extend trade credit. However, we find evidence consistent also with the collateral liquidation motive proposed by Longhofer and Santos (2003) and Frank and Maksimovic (2005), as the higher the proportion of service inputs relative to standardized inputs, the lower the volume of trade credit taken.

We also show that sectors that undertake little or no transformation of the product - wholesale and retail for example - receive more trade credit than other sectors, further confirming the argument we propose. We determine that firms lose the advantage in collateral liquidation as the inventories are processed by their customers from raw material form to work in progress, semi-finished and finished goods. The advantage we have over the original test employed by Petersen and Rajan (1997), which used average data for the firms in the same two-digit SIC category from Compustat, is that we have the proportion of goods at four stages of fabrication at the individual firm-level in our inventory data.

The following section presents briefly the background literature that motivates our empirical model for the extension of trade credit. Section 3 describes the data and summary statistics. In section 4, we present our empirical model and the methodology used. Section 5 presents our empirical work and in the final section we conclude.

2 Related Literature

There has been a long running debate about the motives suppliers and customers face in offering or receiving trade credit, many of which are summarized and then evaluated in

Peterson and Rajan (1997).[2] We summarize below the three strands of this literature and dwell in more detail on the papers more closely related to ours.

2.1 Specialized goods and trade credit

Recent work by Burkart and Ellingsen (2004), Cuñat (2007), and Fabbri and Menichini (2010) stresses that the motives discussed by Petersen and Rajan are greatly influenced by the nature of the transacted good. Burkart and Ellingsen (2004) point out that the advantage of trade credit lies in its illiquid nature, which is not easily diverted as cash inputs might be. Giannetti et al. (2011) further note that the more standardized the product transacted the easier it is to divert its use to other purposes, and the easier it is to find alternative suppliers, so customer-seller relationships are weak and price discrimination through trade credit may be harder. As a product becomes more specialized in nature it has fewer alternative uses and fewer suppliers, which strengthens the relationship between customer and supplier that Petersen and Rajan (1997) found to be important. Giannetti et al. (2011) establish that manufacturing firms that sell or buy differentiated goods use more trade credit than do those with standardized goods, or those from other industrial sectors. This is true for trade credit offered by sellers and trade credit received by buyers in separate tests.

Cuñat (2007) argues that there is another reason for trade credit to increase when a firm uses a specialized product. Buyers and sellers enter symbiotic relationships in which neither has the incentive to damage the trust that exists between them. First, when goods are specialized, and sellers are difficult to replace, credit enforcement is easier for suppliers than for financial intermediaries. Second, suppliers offer credit when banks will not, and insure against liquidity shocks. They do this because trade credit is forward looking (based on future sales and business) while bank lending is backward looking (based on collateral accumulated). This reinforces the customer-seller relationship further and encourages greater trade credit where goods are specialized. Finally, suppliers offer signals of reassurance to other creditors, e.g. banks, about the creditworthiness of their customers, and hence in equilibrium firms obtain bank and trade credit. In these circumstances, Cuñat (2007) predicts that trade credit volumes increase where the transacted good is specialized.

[2] A list of the most prominent theories includes information asymmetry (Smith, 1987), signalling (Biais and Gollier, 1997), price discrimination arguments (Brennan et al., 1988), financial monitoring advantages (Jain, 2000 and Mateut et al., 2006), product quality (Smith, 1997, Lee and Stove, 1993 and Long et al., 1993), redeployment of goods after default (Frank and Maksimovic, 2005 and Wilner, 2000), opportunistic behavior (Burkart and Ellingsen, 2004, Fabbri and Menichini, 2010) and inventory transactions costs (Ferris, 1981, Emery, 1987, Bougheas et al., 2009, Daripa and Nilsen, 2011).

2.2 Inventories and trade credit

The literature by Ferris (1981), Emery (1987), Petersen and Rajan (1997), Longhofer and Santos (2003), Frank and Maksimovic (2005), Bougheas et al. (2009), and Daripa and Nilsen (2011) explores inventory transactions costs as a motive for offering trade credit. The underlying argument suggests that suppliers may offer trade credit as an incentive to buyers to hold higher stocks of inventories - shifting inventory holding from seller to buyer - but there are subtle differences between the theories proposed.

Bougheas et al. (2009) is based on a storage cost model, where the seller faces a stochastic demand. Firms have an incentive to extend trade credit to their customers in order to promote sales rather than accumulate costly inventories of finished goods. This incentive is limited only by the need to obtain liquidity to meet their own obligations, producers might readily offer trade credit on appropriate terms to enhance sales and boost demand. The model is driven by the capacity a firm has to store finished goods, and this is disproportionately larger for bigger firms compared with smaller firms.

Daripa and Nilsen (2011) have a related but different model. It is the downstream buyer that faces the stochastic demand not the supplier. Two periods are necessary to produce the final product as each production process (supplier input and final product) takes one period. An unsatissfied final consumer may return after one period but does not return after two periods. In the face of demand uncertainty, the final good producer decides whether to hold inventory to meet sales or to order supplies when final demand for goods arrives. The decision is influenced by the inventory financing costs faced by the downstream firm, often through bank loans.

Trade credit arises in the Daripa and Nilsen (2011) model whenever upstream firms find it optimal to offer their downstream buyers an incentive to purchase inventories and continue production. Consider now the implication of our argument for inputs that need to be further processed by the downstream firm. Since processing inputs takes time, it reduces the linkage between an order for final good arriving on the one hand, and placing an order for the input (from the upstream firm) on the other hand. In other words, processing of inputs lowers the downstream firm's incentive to wait and see if a final-good order arrives. This suggests that an upstream firm has less of an incentive to provide trade credit to customers which process (a large proportion of) their inputs than to customers which do not. This could explain our finding that firms in the wholesale and retail sectors, where no such processing is involved, have higher waiting incentives, and therefore are offered larger trade credit

provision. Similarly, upstream firms with a higher proportion of processed goods have a higher incentive to extend more trade credit.

2.3 Collateral liquidation and trade credit

The theory supported by Petersen and Rajan (1997), Longhofer and Santos (2003), and Frank and Maksimovic (2005) refers to the collateral liquidation motive. A producer firm has advantages in selling a repossessed good when a customer fails to pay for it compared to a bank that might seize the good as collateral in the face of non-payment of a loan. The firm has an established sales network and can redirect the good to its other customers, while a bank has no such network. The lower transactions costs in repossession induce a seller to offer the goods on trade credit since they are easily redirected if the customer fails to pay for them. This comparative advantage will be more pronounced for differentiated goods because they are tailored to the needs of fewer customers, and it is harder to identify suitable buyers and to obtain reference prices (Fabbri and Menichini, 2010). This should contribute to shield suppliers of differentiated goods and services against buyer opportunism (Burkart and Ellingsen, 2004) in the same way as strong relationships with customers do. Therefore trade credit should be greater where suppliers can enforce payments more readily through the threat of termination of the specialized supply and seizure of goods supplied, and buyers should have less incentive to renege on payments of trade credit where it is offered. Almeida and Campello (2007), Campello and Giambona (2011) and Campello and Hackbarth (2012) refer to the saleability or tangibility of assets as a means to relax conditions for firms that are financially constrained. Although their argument applies to fixed capital investment, there is no reason, in principle, why it might not also apply to trade credit and inventory financing. Essentially, if the firm's inventories are mostly processed, an increase in the firm's inventories supplied on trade credit does not correspond to a boost in recovery values, which is the lenders' "enforceable" outside option in case of contract renegotiations.

3 Data and summary statistics

3.1 Data Source

Our main data source is the profit and loss account and balance sheet data gathered by Bureau van Dijk in the Diane database, which provides a nationally representative sample of French companies. The majority of the firms included in the dataset are not traded on the

stock market and this means we are likely to observe a large proportion of small and medium sized firms. We include firms with more than three consecutive yearly observations and drop the 1 percent tails for each of the regression variables to control for the potential influence of outliers. The final sample includes information about over 82,000 French firms observed between 4 to 8 consecutive years. This gives us an unbalanced panel with about 583,429 firm-year observations on firms in different economic sectors over the time period 2000-2007. The size of the dataset is considerably larger than other databases with a similar range of financial information used for the study of trade credit taken and offered (e.g., larger than the 3,489 US firms in the Giannetti et al. (2011) study based on the 1998 NSSBF cross-section data, and larger than the 39,500 firms Cuñat (2007) uses from the Bureau van Dijk Fame database, covering manufacturing, retailers and wholesalers). Most importantly, we have the advantage of more detailed information on the types of inventories held by firms which enables us to consider the inventory stage of fabrication motive.

The database provides detailed industry-specific information that allows us to identify the characteristics of the traded products. The largest single sector in our database is manufacturing, which comprises 24% of our total observations, and the remainder is made up of construction (21%), retail (16%), wholesale (12%), and services (28%), which includes tourism, financial services, real estate and others as recorded in Table 1. To test whether trade credit extension is correlated with product characteristics, we separate manufacturing firms producing differentiated goods from firms producing standardized goods as in Giannetti et al. (2011), following the classification of Rauch (1999). The data appendix gives the assignment of the UK 2003 SIC codes to differentiated and standardized goods categories. There are 89,603 observations for differentiated goods manufacturers and 52,190 observations for standardized goods manufacturers.

<Table 1 about here>

The Diane database also has vital information allowing us to separate total inventories according to their stage of fabrication. This gives us a further advantage in testing the inventory transactions cost model. We can separate inventories in total into four sub-categories of inventories in the French accounting system. These are: a) raw materials and consumables, which are the basic materials purchased from other firms to be used in the firm's production operations, b) work in progress, which are partially finished goods requiring (important) additional work before they become finished goods (more than 50% of the production process remains to be completed), c) semi-finished and finished goods, which require some minor

additional work before they become goods for sale (less than 50% of the production process remains to be done), and d) goods for sale, which are goods on which the production has been totally completed but that are not yet sold. From these categories we construct total inventories from items a) - d), and processed inventories from items b) - d), which is the sum of work in progress, semi-finished and finished goods, and goods for sale. As more work is done to the inputs they are more dedicated to the owner and less easily re-sold when salvaged by the supplier, but in addition, inventories of differentiated goods manufacturers have fewer diversion opportunities than those of standardized manufacturers at every stage of production. This provides a more detailed test of the impact of differentiation of goods on trade credit than the test that separates firms into industries.

3.2 Sample Descriptive Statistics

Table 2 reports the summary statistics for our sample of firms separated into industrial sectors giving mean values and standard errors in brackets. We report in the first column all manufacturing firms, and in columns 2 and 3 the manufacturers separated into differentiated goods producers and standardized goods producers. Columns 4 and 5 report results for construction and retail sectors.[3]

< Tables 2A and 2B about here >

From Table 2A, we notice first of all the striking difference in the ratio of trade credit extended to sales ($TCextended$) across sectors and across differentiated and standardized goods categories.[4] Manufacturing firms producing differentiated goods sell on credit about 50 per cent more sales than manufacturing firms producing standardized goods. Construction firms sell a similar amount of goods on credit as differentiated manufacturers, while retailers sell very little. By contrast, the uptake of trade credit does not differ much across sectors, with firms in all sectors taking up a similar proportion of trade credit in sales. It is not unusual to observe similar trade credit received across sectors, since it depends on the characteristics of the inputs used, i.e. the proportion of differentiated versus standardized and service inputs. Firms producing differentiated goods extend three times more net trade

[3]The sample period is 1999-2007 for manufacturing and construction firms. Data for services providers is available only from 2000 onwards. Therefore, results presented separately for retail firms and for the whole sample in Tables 1, 3, 7 and 8 refer to the period 2000-2007.

[4]In line with Petersen and Rajan (1997, p. 667 - 668) and Giannetti et al. (2011, p. 16 - 17), we fully recognise the simultaneous supply and demand issues in trade credit transactions in refering to accounts payable and accounts receivable as trade credit taken/received. To address this, we control for a large number of firm-specific characteristics and pick up systematic differences between sectors with industry dummies, or intercepts in separate regressions for each industry.

credit ($NetTC$) than firms producing standardized goods, but they have very similar levels of net trade credit (trade credit taken - extended) to the construction sector. The retail sector has positive net trade credit, indicating that unlike other sectors it receives much more trade credit than it offers - our conjecture about the role of processed inventories is able to explain this result because retailers do not process their inventories, and so they are offered more trade credit. Given that the customers of the retail sector are mostly end consumers buying goods for cash or using credit cards that clear balances relatively quickly (Petersen and Rajan, 1997), this sector does not extend much trade credit.

We examine the bank loans and measures of inventory holdings in total and separated into the categories raw materials only and inventories excluding raw materials (all scaled by turnover) across sectors. The construction sector and the differentiated manufacturing sector has a lower ratio of bank loans to turnover. Inventories, raw materials and processed inventories show that the construction sector has lower inventories than other sectors, and manufacturers of all types have very similar levels of total inventories and raw materials. The retail sector has few raw materials, holding mostly finished goods, consistent with their activity as retailers of goods to end consumers.

The measures of scale such as real assets and real sales are reported in logarithms. Standardized goods manufacturers are larger on the basis of real assets and real sales compared to differentiated goods manufacturers. Retailers appear smaller still in terms of real assets, but their real sales are the largest in any sector. Construction firms have the smallest real assets and real sales. Retail firms have been established for a longer period than manufacturing firms and construction firms (on average), but standard deviations within the sub-samples are large suggesting that there are a mixture of older and younger firms in each sector.

Other characteristics of the firms reported are profitability, measured as profit over turnover, and liquidity, measured as current assets minus inventories and trade credit offered over turnover. We find that retailers and manufacturers of standardized goods have lower profitability than other sectors, and the retail sector has a lower liquidity ratio at 0.09 compared with other sectors in the range 0.123 - 0.130. The measure of risk takes ten values, representing deciles of the risk distribution, with higher values indicating a higher likelihood of corporate failure in the next 12 months.[5] Retail firms have a higher risk measure on average than firms in manufacturing or construction, but the mean values for manufacturers (differentiated and standardized) and construction firms are more similar. The probability

[5] The data appendix details the factors that contribute to the risk score and the aggregation procedure.

of default implied by these average risk measures is between 10 and 20 percent for manufacturers and construction firms, and between 20 and 30 percent for retailers.

Breakdown of the data into different sizes by sector are reported in Table 2B. Firms are considered to be large if their mean real assets are in the top quarter of the distribution of average real assets for all firms operating in the same industry group. Large firms hold on average 50% higher inventories relative to sales than do small firms and this is even more relevant when we look at the ratio of work in progress and finished goods to sales, supporting the findings of Bougheas et al. (2009). The test of equality of p-values reported in the columns labeled 'diff' demonstrate clearly that, with a few exceptions, the mean values are significantly different in each comparison, and this confirms our findings in unreported tests of equality of means between different sectors where firm sizes are not distinguished.

4 Empirical specification and estimation

We start our empirical analysis for trade credit extended from the suppliers perspective by initially estimating the following equation:

$$\begin{aligned} TCextended_{it} &= \alpha_i + \beta_1 Inventories_{it} + \beta_2 X_{it} + \beta_3 Differentiated_i + \beta_4 Services_i + \\ &+ \beta_5 \mathrm{Re}\, tail_i + \beta_6 Wholesale_i + d_t + u_{it} \end{aligned} \tag{4.1}$$

where $TCextended_{it}$ is trade credit extended scaled by sales. The stock of inventories ($Inventories_{it}$) measure the incentives firms face to increase sales (and reduce inventories) by offering trade credit. We have two variants of our model: the first has a measure based on total inventories ($Total\_Inv_{it}$) and a second version where we use processed inventories ($Processed\_Inv_{it}$). The former measures all inventories, while the latter excludes raw materials. We expect processed inventories to be more dedicated to the owner than raw materials, and to create a greater incentive to obtain sales, through trade credit if necessary.[6]

We control for firm-specific (α_i), time-invariant (d_t), and sector specific effects (*Differentiated*$_i$, *Services*$_i$, *Retail*$_i$, and *Wholesale*$_i$). The omitted category is *Standardized*$_i$. The sector specific effects allow us to test for the influence of the type of good on the trade credit

[6] In a different context, Caggese (2007), Tsoukalas (2011), and Wen (2011) use the stage of fabrication of inventories to provide an analysis of input and output inventory dynamics in macroeconomic models. These papers refer to raw materials and work in progress as input inventories, and finished goods as output inventories. We define processed inventories as those that have been worked, either by the seller or by the customer, and are therefore dedicated in some respects to the buyer. This is more consistent with the concept of differentiated goods used in the trade credit literature that we address.

extended. X_{it} is a vector of controls accounting for the supply side influences on trade credit extended, including the amount of bank loans ($BankLoans_{it}$), which controls for alternative sources of finance that might allow firms to offer trade credit while continuing production; the measure of the likelihood of company failure in the near future ($Risk_{it}$); $Profits_{it}$ given by the firm's profit (or loss) for the period; and $Liquidity_{it}$ defined as firm's gross liquid assets (cash, bank deposits, and other current assets excluding accounts receivable and stocks). With the exception of $Risk_{it}$, which is scale free, all variables are scaled by total sales. The logarithm of the firms' book value of assets controls for size effects ($Size_{it}$).

This model is estimated using the system generalized method of moments (SYS-GMM) where we control for the endogeneity of the regressors by using lags of each of the regressors as instruments. Time dummies are included in all our regressions and in the instrument matrix. We report tests for serial correlation and the Hansen test for the legitimacy of variables dated t-2 and further as instruments in the differenced equation.[7] We also estimate the model using the Hausman-Taylor (HT) and the random effects (RE) estimator to provide evidence of the robustness of the results to different estimation methods.[8]

We then model trade credit extended from the sellers' perspective in more detail. First, with the benefit of a much larger sample, we are able to estimate the trade credit extended equation separately for manufacturers with differentiated and standardized goods, and also for construction and retail sectors. We expect the use of trade credit to differ across industries because empirical studies have found wide variations across industries but rather similar credit terms within industries (Ng et al., 1999; Nilsen, 2002), and the reliance of firms on internal finance relative to external finance follows an industry pattern. We control for firm-specific (α_i), time-invariant (d_t), and industry-specific effects (v_{jt}).

$$TCextended_{it} = \alpha_i + \beta_1 Inventories_{it} + \beta_2 X_{it} + d_t + v_{jt} + u_{it} \tag{4.2}$$

[7] The serial correlation tests are asymptotically distributed as a standard normal under the null of no serial correlation of the differenced residuals. Under the null of instrument validity, the Hansen test for over-identifying restrictions is asymptotically distributed as a chi-square with degrees of freedom equal to the number of instruments less the number of parameters. All GMM models are estimated using the xtabond2 estimator developed by Roodman (2009).

[8] We use the system and not the first difference GMM estimator as the latter cannot control for time invariant sector specific effects ($Differentiated_i$, $Services_i$, $Retail_i$ and $Wholesale_i$). Similarly, time invariant sector effects cannot be accomodated in a fixed effects (FE) estimation. Therefore, to check robustness of results to the choice of estimator we use the random effects (RE), which assumes that regressors are not correlated with unobserved heterogeneity, and the Hausman-Taylor (HT) estimator, which allows some regressors to be correlated with the individual fixed effects, but still does not allow for endogeneity of the regressors with the error term.

Second, we are able to estimate separately the response of small and large firms in differentiated and standardized manufacturing firms, construction, and retail industries, where the size of the firm is determined relative to the industry. Firms are considered to be large if their mean real assets are in the top quarter of the distribution of the average real assets for all firms operating in the same industry. Firms are not allowed to transit between categories. It is important to control for differences in size because a firm's relationship with its bank can differ with its scale, and Daripa and Nilsen (2011) argue bank loans are used to finance inventories in the absence of a subsidy through trade credit. By controlling for size within industry this also allows for the effect of scale and industry on the cost of holding inventories, since inventory costs differ significantly across industries (Fazel, 1997; Shirley and Winston, 2004), and therefore the incentive firms face to generate sales by offering trade credit.[9]

Finally, we explain trade credit taken by estimating the following model:

$$\begin{aligned} TCtaken_{it} &= \alpha_i + \beta_1 Inventories_{it} + \beta_2 X_{it} + \beta_3 Pdiff_{it} + \beta_4 Pserv_{it} + \\ &\quad + \beta_5 \,\mathrm{Re}\, tail_i + \beta_6 Wholesale_i + d_t + u_{it} \end{aligned} \tag{4.3}$$

where the variables are similarly defined as in the previous model, but $TCtaken_{it}$ is the trade credit taken scaled by assets, $Pdiff_{it}$ is the proportion of differentiated goods inputs used by the firm, and $Pserv_{it}$ the proportion of service inputs used by the firm (defined as inputs from non-manufacturing industries over total inputs). Giannetti et al. (2011) argue that firms with a larger proportion of differentiated goods suppliers will take more trade credit than firms with more standardized goods suppliers, and similarly, those with more services will receive more trade credit. Once again, this model is estimated using the system generalized method of moments (SYS-GMM) which allows us to control for time-invariant sector-specific effects.[10] In a variant of this model we add the variable $PropProcessed\_Inv_{it}$ which measures the share of work in progress and finished goods in total inventories. Firms with a high proportion of goods that have been processed have relatively few goods to seize in raw material form, and the collateral liquidation advantages to the supplier will diminish.

[9] All these models are estimated with first difference GMM. Industry specific time dummies are included in all specifications both as regressors and as instruments. Consistent with Bougheas et al. (2009) and Blundell et al. (1992), we identify four main industries within the standardized sector and five main industries within the differentiated sector. The data appendix describes the two-digit SIC codes included in each industry group. Results using other estimators are comparable, and are available from the authors on request.

[10] Again the Hausman-Taylor (HT) and the random effects (RE) estimator provide robustness checks on the estimation method.

5 Empirical results

5.1 Trade credit extended

Our first empirical result is reported in Table 3, where we present our findings from the full panel of data comprising 583,429 firm-year observations of 82,082 French firms in the period 2000 to 2007. We start our analysis with the determinants of the volume of trade credit from the sellers' perspective. Our variables in this model follow Giannetti et al. (2011) but we also control for the sellers' stocks of inventories. We report results estimated using system GMM, the Hausman-Taylor (HT), and the random effects (RE) estimator.

< Table 3 about here >

We test for the effect of the characteristics of the transacted goods on trade credit in Table 3. We find that firms classified as differentiated (manufacturing) goods producers have a positive and significant coefficient on an intercept dummy variable, which contrasts with a smaller positive and significant effect for service and wholesale firms, and a negative and significant effect for retailers. This can be interpreted as a demonstration of the lower moral hazard associated with differentiated goods, where there are fewer alternative suppliers if a buyer defaults on payment under the diversion theory; it is also consistent with the collateral liquidation hypothesis, since differentiated goods are more difficult to dispose of without a seller network (Fabbri and Menichini, 2010).

We exploit the specialized information in the Diane dataset which allows us to distinguish among inventories according to their stage in the production process when we explore the relationship between inventories and trade credit. We expect trade credit extended to be influenced to a greater extent by goods that have been processed, that cannot be returned to their supplier. To test this we aggregate the stock of work in progress, semi-finished and finished goods, and goods for sale and scale it by sales for each firm (*Processed_Inv*).

In column 1 of Table 3 we consider first the effect of all inventories, which we find has a negative and significant effect on trade credit extended as expected (since firms simultaneously decide their credit sales and their stocks of inventories). This is consistent with Bougheas et al. (2009), where the cost of holding inventories incentivizes the firm to sell goods on trade credit. It is also consistent with Daripa and Nilsen (2011), according to whom the seller subsidizes the shift of inventories to the buyer. We then notice in column 2 that processed inventories have a stronger relationship with the volume of trade credit extended than total inventories. The coefficient estimate indicates a one percent decrease

in inventories excluding raw materials is associated with a 0.76% increase in trade credit extended (consistent with higher sales volume) which is greater than the coefficient for total inventories. Our argument is similar to the sales motive identified by Wilson and Summers (2002), where firms extend sales by offering goods on account in the first instance, and the subsidy of inventory argument of Daripa and Nilsen (2011) but we make the link between the stage of fabrication of inventories that other authors have not previously assessed.

We introduce a number of controls for firm characteristics in our regressions for profits, liquidity of the firm, and bank loans, measured as ratios over total sales, and our risk measure that gives an indication of default risk on a discrete scale (1-10). Profits in our results has a negative and significant coefficient, meaning higher profits reduce trade credit extended relative to sales. Trade credit provision is left to relatively unprofitable firms. Petersen and Rajan (1997) suggest that firms that are in trouble may use the extension of credit to attempt to maintain their sales. Less liquid firms in our sample extend more trade credit, which is similar to the finding of Petersen and Rajan (1997), who detect a negative relationship between firms' liquidity and their volume of sales on credit. Garcia-Appendini and Montoriol-Garriga (2013) also find firms with higher levels of pre-sample liquidity increased the trade credit extended to other firms, while those cash-poor firms reduced trade credit. Petersen and Rajan (1997), Love et al. (2007) and Cull et al. (2012) argue that firms with access to bank finance may have incentives to offer trade credit to downstream firms that cannot obtain this type of funding.

Our estimates for trade credit extended for each sector separately are presented in Table 4. We split the 19,445 manufacturing firms into differentiated and standardized goods manufacturers, and compare these firms with 14,326 construction firms and 12,207 retailers.

< Table 4 about here >

The most important result in this table is the relationship between trade credit extended and inventories in total and once they have been processed. The negative relationship between trade credit extended and inventories (in columns 1-4) is stronger in the differentiated manufacturing sector and the construction sector than for other sectors. The hypothesis that the diversion theory should more strongly apply to inventories of goods with fewer alternative uses or buyers is confirmed. Also, the coefficient on processed inventories (in columns 5-8) is larger in absolute value than the coefficient on total inventories (in columns 1-4) for all sectors. This offers support for our conjecture that partly processed or fully finished goods are more differentiated and less divertible than the raw material inputs, and for these types

of goods the manufacturer has a stronger incentive to generate sales by offering trade credit. As far as we are aware there is no previous work that has tested this hypothesis.

The breakdown of the sample into these sectoral sub-samples, allowing for the type of goods, does not make major changes to the results for other controls reported in Table 3, however, firm size has greater influence on trade credit extended than before for manufacturers of differentiated goods, and construction firms. We also find that access to bank finance plays a more important role in the decision to extend trade credit for firms producing differentiated goods. Differentiated goods have a lower collateral value and therefore bank lending in the differentiated sector is lower than in the standardized goods sector. This result is in line with the summary statistics and supports the diversion value hypothesis in Giannetti et al. (2011). As firms in the differentiated sector are more constrained in their access to external funding, a unit increase in their bank loans leads to a marginally larger impact on their volume of trade credit extended relative to sales than in the case of firms in the standardized sector.

5.1.1 Supplier size

Given that the results in Table 4 seemed to show size matters for firms in different sectors, we now estimate the trade credit extended equation for small and large firms in different industries, using the 75 percentile of the real asset distribution as the cutoff point (using a cutoff of 66 percent instead produces similar results). The separation into small and large firms relative to the industry allows for the fact that there are substantial differences in access to finance (Ng et al., 1999; Nilsen, 2002) and inventory costs (Fazel, 1997; Shirley and Winston, 2004) across industries. In particular, by splitting firms into size categories we are able to test whether smaller firms with higher inventory holding costs, following Bougheas et al. (2009), and therefore with more incentive to persuade customers to hold inventories, as explained in Daripa and Nilsen (2011), offer more trade credit than firms that are larger. We further suggest that once goods have been processed they are more dedicated to the firm and therefore the firms that already have incentives to induce sales with trade credit should face greater incentives if a greater proportion of their inventories are processed.

< Tables 5A and 5B about here >

Tables 5A and 5B consider size categories within each industrial sector and make allowance for differentiated and standardized goods manufacturers separately. The trade credit extension of small firms displays a greater sensitivity to total inventories in Table 5A and to

processed inventories in Table 5B. This confirms that smaller firms have a stronger inventory transactions cost motive for offering trade credit compared to larger firms for all industries not just manufacturing, consistent with Bougheas et al. (2009).

We find that there is greater sensitivity to bank loans for smaller firms than for larger firms in all industrial sectors. Berger et al. (2005) document that differences in firm size (and accounting records) affect the nature of the bank-firm relationship and the availability of bank credit. Therefore small firms are typically more likely to be credit constrained than larger firms. In line with Bougheas et al. (2009) and Petersen and Rajan (1997), we find that firms with better access to credit offer more trade credit. This could mean, at the margin, that access to bank loans would allow financially constrained smaller firms to offer trade credit and continue to finance production, while larger firms would be less likely to face a constraint.

In all our specifications, we include industry specific time dummies to control for industry characteristics, and the resulting models satisfy the conditions required in GMM of non-rejection of the hypothesis 'no serial correlation in the errors' and non-rejection of the Hansen test with only a few exceptions. In unreported specifications, we replace the industry dummies with an industry concentration index as in Giannetti et al. (2011), but the industry concentration variable does not perform well, although all our results remain intact. We also control for the age of the firm, which does not change our results, and similar to Giannetti et al. (2011), we find that firm age does not have a consistent impact on trade credit extension.

The empirical results reported in Tables 3 through 5 confirm the new prediction in our paper that processed inventories have a larger impact on trade credit than total inventories. Once work is done to the inputs they are more dedicated to the owner, and cannot be returned to the upstream seller: there is no going back, which creates stronger incentives for firms processing inputs to offer trade credit.

5.2 Trade credit taken

We turn now attention to trade credit taken by firms. In order to link trade credit taken with the characteristics of the traded products we need to identify the nature of the various inputs the firms purchase. We construct the variables $Pdiff_{it}$ (the proportion of differentiated goods inputs used by the firm) and $Pserv_{it}$ (the proportion of service inputs from non-manufacturing industries over total inputs) to consider the effect of the type of goods used on trade credit taken. The information is derived from the input-output tables from INSEAD.

As these variables do not vary much (if at all) over time and we want to include also dummies for firms in retail and wholesale, we use again the SYS-GMM estimator.

< Table 6 about here>

The results in Table 6 are reported for all 81,287 firms that are split into 61,160 small firms and 20,127 large firms using a 75% cutoff in the real asset distribution. The results confirm that firms that purchase a higher proportion of differentiated inputs buy more on credit from their suppliers. On the contrary, a higher proportion of service inputs relative to standardized inputs lowers the volume of trade credit taken. These results are consistent with the lower moral hazard associated with differentiated goods, as mentioned in the previous section, where there are fewer alternative suppliers if a buyer defaults on payment, and support the findings of Giannetti et al. (2011) and Daripa and Nilsen (2011). Our results are also consistent with the collateral liquidation hypothesis due to Longhofer and Santos (2003), Frank and Maksimovic (2005), Cuñat (2007) and Fabbri and Menichini (2010), as differentiated products are worth more in the hands of their suppliers. This advantage is absent in the case of service suppliers as services have no liquidation value.[11]

<Table 7 about here>

In Table 7 we investigate the advantages of collateral liquidation. Petersen and Rajan (1997) argue that as inventories become more specialized they are more difficult to dispose of, making it less likely that a seller will have a strong advantage over any other creditor in the disposal of repossessed goods. They are able to approximate this effect using a measure of liquidation costs, defined as the share of finished goods in the total inventory averaged across firms in the same two-digit SIC category. Here we have much greater detail on the nature of inventory, and we record this for each firm in our dataset. Therefore we construct

[11]The legal system could prevent the supplier from seizing particular goods, and therefore, limit the liquidation motive for trade credit. For example, the U.S. laws allow suppliers to repossess the good only within 10 days from delivery, unless they establish a lien, which is a costly and infrequent practice. However, the EU Directive 2011 (replacing EU Directive 2000/35/EC), which regulates all commercial transactions in France and aims to improve the functioning of the EU internal market, recommends that "Member States shall provide in conformity with the applicable national provisions designated by private international law that the seller retains title to goods until they are fully paid for if a retention of title clause has been expressly agreed between the buyer and the seller before the delivery of the goods." There is no time limitation on repossession. In the extreme case that the buyer cannot meet its financial obligations, it may file for bankruptcy. The pro-debtor French bankruptcy law was explicitly intended to save bankrupt firms in order to protect employment and reduce domino effects on suppliers or trade creditors, who are often junior or unsecured claimants and face financial distress following the bankruptcy of their clients. But the reform implemented in 2006 aimed to render bankruptcy more creditor friendly, and the 2009 law stipulates that the ownership of property may be held as collateral by the effect of a retention of title clause which suspends the effect of a conveyance contract until full payment of the obligation which is its counterpart. This makes French law more supportive of creditors in bankruptcy than it once was.

a similar liquidation cost variable based on the share of work in progress plus finished goods to total inventories for each firm and re-evaluate the results reported in Table 6. We expect to find that the larger the ratio the greater the liquidation costs for the supplier if they should repossess the goods offered on trade credit, and indeed as liquidation costs increase (due to the larger proportion of processed inventories in the form of work in progress, semi-finished and finished goods) so the trade credit taken falls in our results. This confirms the finding of Petersen and Rajan in our data, since there is a consistent and significantly negative coefficient irrespective of the estimation method used, but it also tells us that the impact of these liquidation costs are larger for bigger firms. A weakened collateral liquidation motive reduces the incentives to the seller to offer trade credit, and it works in the opposite direction to the diversion hypothesis. It also shows that the saleability hypothesis proposed by Campello and Hackbarth (2012) applies to trade credit and inventory financing since an increase in the firm's inventories supplied on trade credit does not boost recovery values if inventories are processed.

In both Tables 6 and 7 we find that retail and wholesale firms take more trade credit than other sectors as indicated by the positive and significant coefficient on the dummy variable indicating the firm belongs to one of these sectors. This provides confirmation of our conjecture that processed inventories diminish the advantages from collateral liquidation, because goods sold by upstream firms (mainly manufacturers) to retailers and wholesalers are not processed, they are stored and sold to their end consumers. Hence, the suppliers retain their comparative advantage in repossessing their goods if retailers/wholesalers do not pay on time. According to our hypothesis this explains why suppliers have a stronger incentive to extend trade credit to wholesalers and retailers than to other firms which transform the goods. Previous theories discussed above do not offer a reason for this finding in their results.

6 Conclusions

This paper proposes that the production process alters the incentives for firms to offer and receive trade credit for three reasons. We argue that the stage of fabrication of inventories has a bearing on the diversion, inventory management and collateral liquidation theories. First, while the diversion theory acknowledges that the degree of specialization can positively affect the willingness of firms to offer trade credit, our paper shows that goods become more specialized as they go through the production process. In downstream industries where a large proportion of inventories are held in unprocessed form they are more vulnerable to

diversion than in industries where a large proportion are processed affecting their access to trade credit. Second, it is necessary to recognize that the incentives to minimize inventory are greater if a firm has a high proportion of finished goods compared to raw materials or work-in-progress. Third, we propose that the advantages that upstream firms have over banks in collateral liquidation theories diminish as the goods are influenced by the fact that goods are processed. As Petersen and Rajan (1997, p. 664) have argued, 'The advantage of suppliers over financial institutions will vary cross-sectionally depending on the type of goods the supplier is selling and how much the customer transforms them.' These effects often operate contrary to one another, but they all underline that the production process affects access to short-term credit, and may shift the incentives for firms to seek credit from suppliers rather than banks.

Using a panel dataset of about 82,000 French firms in several economic sectors, we are able to show that as more work is done to the inputs they are more dedicated to the owner; inventories of differentiated goods manufacturers have fewer diversion opportunities than those of standardized manufacturers at every stage of production, and that the seller does have greater incentive to obtain sales by using trade credit as an inducement to the customer to purchase the goods. We also find that trade credit extended shows greater sensitivity to processed inventories compared to total inventories, and that this effect is more powerful for smaller firms compared to larger firms in a range of different industries. Finally, when examining trade credit received we find that firms that have a higher proportion of processed inventories receive less trade credit, since the seller loses the collateral liquidation advantages as goods are processed. Wholesale and retail sectors, which undertake little or no transformation of the product, receive more trade credit than other sectors that process their inputs, further confirming the argument we propose. We conclude that there is no going back once firms have processed goods, and this affects their willingness to offer and receive trade credit.

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Data Appendix

Definition of variables

TCextended= trade credit extended; balance sheet variable account receivables scaled by firm turnover

TCtaken = trade credit taken; balance sheet variable creditors scaled by firm turnover

NetTC = net trade credit; it is trade credit taken (*TCtaken*) minus trade credit extended (*TCextended*)

BankLoans = bank borrowings scaled by turnover

Total_Inv = total inventories scaled by turnover

There are four types of inventories in the French accounting system:

1. raw materials and consumables = the basic materials purchased from other firms to be used in the firm's production operations,

2. work in progress = low partially finished goods requiring (important) additional work before they become finished goods (more than 50% of the production process remains to do),

3. semi-finished and finished goods= high partially finished goods requiring (weak) additional work before they become goods for sale (less than 50% of the production process remains to do)

4. goods for sale= goods on which the production has been totally completed but that are not yet sold.

Processed_Inv = the sum of work in progress, semi-finished and finished goods, and goods for sale scaled by turnover

Profits = profit/loss for the period scaled by turnover

Liquidity = liquid assets (current assets minus inventories and accounts receivable) scaled by turnover

Risk = measures the probability that the firm will be in default in the near future. It takes 10 values (1-10), with higher values indicating higher risk. It is based on the Financial Score Conan-Holder (NPC) calculated as: NPC = 24*R1+22*R2+16*R3-84*R4-10*R5,

where

R1=operating cash flow excluding extraordinary items, interest, dividends and royalties / total debt

R2=long-term capital (equity + long-term debt) / balance sheet total assets

R3=[current realizable assets + cash] / balance sheet total assets

R4=interest expenses / net turnover

R5=personnel expenses / added value

Risk = 10 if NPC < -4, i.e. a 90% probability of default in a near future,

= 9 if -4 <= NPC < 0, i.e. there is 80% probability of default in a near future,

= 8 if 0 <= NPC < 2, i.e. there is 70% probability of default in a near future,
= 7 if 2 <= NPC < 5, i.e. there is 60% probability of default in a near future,
= 6 if 5 <= NPC < 6, i.e. there is 50% probability of default in a near future,
= 5 if 6 <= NPC < 8, i.e. there is 40% probability of default in a near future,
= 4 if 8 <= NPC < 10, i.e. there is 30% probability of default in a near future,
= 3 if 10 <= NPC < 13, i.e. there is 20% probability of default in a near future,
= 2 if 13 <= NPC < 16, i.e. there is 10% probability of default in a near future,
= 1 if NPC >= 16.

Our results are robust to using a less detailed definition of the variable risk.

Risk2 = 5 if NPC <-5,
= 4 if -5 <= NPC < 4,
= 3 if 4 <= NPC < 10,
= 2 if 10 <= NPC < 16,S
= 1 if NPC >= 16.

Size = logarithm of real total assets

Age = number of years since the firm was established

Differentiated = 1 if the manufacturing firm produces differentiated goods, 0 otherwise. See Sector classification of firms.

Standardized = 1 if the manufacturing firm produces standardized goods, 0 otherwise. See Sector classification of firms.

Services = 1 for non-manufacturing firms excluding *Retail* and *Wholesale*, 0 otherwise.

Retail = 1 for a retail firm, SIC code 50 and 52, 0 otherwise.

Wholesale = 1 for a wholesale firm, SIC code 51, 0 otherwise.

Pdiff = proportion of differentiated inputs in total inputs used by firms in the same industry. Values calculated using data from the input-output tables with 117 entries available from INSEAD.

Pserv = proportion of service inputs in total inputs used by firms in the same industry. Values calculated using data from the input-output tables with 117 entries available from INSEAD.

PropProcessed_Inv = proportion of processed inventories (work in progress, semi finished and finished goods) in total inventories.

Sector classification of firms

The classification of the manufacturers as differentiated or standardized is based on Rauch (1999). All other industries are classified as services.

UK SIC 2003	Manufacturing	Diff	Industry
15	Food products and beverages	0	S1
16	Tobacco products	0	S1
17	Textiles	0	S2
18	Wearing apparel; dressing and dyeing of fur	0	S2
19	Tanning and dressing of leather; luggage, handbags, saddlery harness and footwear	0	S2
20	Wood and products of wood and cork, except furniture; articles of straw and plaiting materials	0	S3
21	Pulp, paper and paper products; publishing and printing	0	S3
22	Publishing, printing and reproduction of recorded media	1	D1
23	Coke, refined petroleum products and nuclear fuel	0	S4
24	Chemicals and chemical products	0	S4
25	Rubber and plastic products	1	D2
26	Other non-metallic mineral products	0	S4
27	Basic metals	0	S4
28	Fabricated metal products, except machinery and equipment	1	D3
29	Machinery and equipment not elsewhere classified	1	D4
30	Office machinery and computers	1	D4
31	Electrical machinery and apparatus not elsewhere classified	1	D4
32	Radio, television and communication equipment and apparatus	1	D4
33	Medical, precision and optical instruments, watches and clocks	1	D4
34	Motor vehicles, trailers and semi-trailers	1	D5
35	Other transport equipment	1	D5
36	Furniture, manufacturing not elsewhere classified	1	D1

We distinguish four industry groups within the standardized sector (S1 to S4) and five industry groups within the differentiated sector (D1 to D5) in line with Bougheas, et al. (2009) and Blundell, et al. (1992). The last column of the table assigns the UK SIC 2003 codes to the nine industry groups. As we believe firm size is industry specific, we classify firms as large if their mean real assets are in the top third of the distribution of average real assets for all firms operating in the same industry group. For instance, firms operating in industry group S1 (food products and beverages, and tobacco products) are considered large if their average real assets over the sample period are in the top third of the distribution of mean real assets of all firms operating in industry group S1. Firms do not change their size category over time. For a similar approach see Brown et al. (2009).