Credit Scores and Credit Market Outcomes: Evidence from the Survey of Small Business Finances and the Kauffman Firm Survey

by

Rebel A. Cole
Krahenbuhl Global Consulting
Chicago, IL 60602

for

SBA
Office of Advocacy
www.sba.gov/advocacy

under contract number SBAHQ-12-M-0168

Release Date: January 2014

***Abstract*:** This study utilizes data from the Federal Reserve Board's Surveys of Small Business Finances (SSBF) and from the Kauffman Foundation's Kauffman Firm Surveys (KFS) to provide new evidence on how business credit scoring affects the availability of credit to female- and minority-owned firms. SSBF and KFS data are analyzed using a three-step sequential model of (i) who needs credit, (ii) who applies for credit, and (iii) who gets credit.

Analyses of data from both surveys show that firms with lower business credit scores are: (i) more likely to need additional credit because their credit needs have not already been met by past borrowings; (ii) more likely to be discouraged from applying for credit when they report a need for additional credit; and (iii) more likely to be denied credit when they need additional credit and apply for credit. However, when the analyses include a comprehensive set of control variables for firm characteristics, owner characteristics, and firm-lender relationships (SSBF data only), results indicate that business credit scores have no incremental explanatory power over that of the control variables, with the notable exception of discouragement of KFS firms. Moreover, the analyses find no evidence that business credit scores have a disproportionately adverse effect on the availability of credit either to (i) female-owned firms relative to male-owned firms or (ii) to minority-owned firms relative to non-Hispanic white-owned firms. Nor is there any evidence from the SSBF data that business credit scores reduce the importance of firm-lender relationships. The analyses do find that minority-owned firms are disproportionately denied credit when they need and apply for additional credit, strong evidence consistent with taste-based discrimination in the small-business loan market.

Contents:

Figures:

Tables:

1. INTRODUCTION

Recent research has documented the paucity of minority-owned and especially black-owned, businesses in the United States. (See, for example, Bates, 1997; Cole and Mehran, 2011; Fairlie, 1999; Hout and Rosen, 2000; Fairlie and Robb, 2007.) Census data indicate that minority-owned firms are smaller as measured by both sales revenues and employment, less profitable as measured by return on assets (ROA, which is defined as net income divided by assets) and less likely to survive (U.S. Census Bureau, 1997). These outcomes are troublesome to policymakers, as self-employment is a key road to economic success. One potential explanation for the poor showing of minority-owned firms relative to white-owned firms is differential access to credit.

The availability of credit is one of the most fundamental issues facing a small business and therefore has received much attention in the academic literature. (See, for example, Petersen and Rajan (1994), Berger and Udell (1995, 1998), Cole (1998) and Cole, Goldberg and White (2004).) If minority-owned firms experience disparate outcomes in the credit markets because of discrimination, then policymakers need to take actions to remedy the situation. Asiedu, Freeman, and Nti-Addae (2012) provide evidence of such disparate outcomes for minority-owned firms, especially for black-owned firms.

This study focuses on the issue of how credit scores affect outcomes in the credit markets. Factors, including credit scores, are analyzed to help explain any disparate outcomes by minority status or gender. Specifically, the analysis looks at which firms needed credit, which firms were discouraged from applying for credit even though they needed credit, and which

firms were approved for credit among those that applied for credit. Data from the 2003 iteration of the Federal Reserve Board's 2003 Survey of Small Business Finances (SSBF) and from the 2008–2010 iterations of the Kauffman Firm Survey (KFS) are used to estimate a sequential logit selection model developed by Cole (2009), where a firm first decides if it needs credit (no-need firms versus need-credit firms), then decides if it will apply for credit (discouraged firms versus denied-credit firms and get-credit firms), and finally learns whether or not it was successful in obtaining credit from a lender (denied-credit firms versus get-credit firms).

Analyses of data from both the SSBF and KFS show that minority-owned firms are disproportionately denied credit when they need and apply for additional credit, strong evidence consistent with taste-based discrimination in the small-business loan market.[1] These analyses also show that business credit scores are important at all three steps of the model. Firms with worse business credit scores are: (i) more likely to need additional credit because their credit needs have not been met by past borrowings; (ii) more likely to be discouraged from applying for credit when they report a need for additional credit; and (iii) more likely to be denied credit when they need additional credit and apply for credit.

However, applying a comprehensive set of control variables for firm characteristics, owner characteristics, and firm-lender relationships, reveals that business credit scores have no incremental explanatory power beyond that of the other control variables, with the notable exception of discouragement of KFS firms. This is unremarkable because Dun & Bradstreet is likely to utilize these or a similar mix of explanatory variables in calculating the business credit

---

[1] Becker (1957) first developed the concept a "taste for discrimination." He defined discrimination as acting as if one were willing to pay money in order to be associated with one group of persons instead of another. Taste-based discrimination is usually distinguished from "statistical discrimination," which results when actors use the average characteristics of groups to predict individual behavior, but may not do so based upon any prejudices.

scores that are tested in this study.[2] Moreover, no evidence is found that business credit scores have a disproportionately adverse effect on the availability of credit either to (i) female-owned firms relative to male-owned firms or (ii) to minority-owned firms relative to non-Hispanic white-owned firms. Nor is there any evidence that business credit scores reduce the importance of firm-lender relationships. Hence, the channel by which minority-owned firms are disproportionately denied credit would appear to run through some other mechanism than business credit scoring.

It is important to note limitations of this study. First, only the D&B business credit score is analyzed, yet surveys have found that lenders use other business credit scores, and use consumer credit scores when underwriting loans to small businesses. This study can only speak to the impact of D&B business credit scores on credit-market outcomes; consumer credit scores and other business credit scores might have different effects on credit-market outcomes. Second, the SSBF data used in this study are now a decade old, predating the 2008 financial crisis. In the current environment, even the D&B credit score may have different effects on credit market outcomes. It is for this reason that the study also looks at data from the 2008-2010 KFS, but those data are most predictive of outcomes for start-up firms, which have much worse credit-market outcomes than established firms. Unfortunately, there are no better databases currently available for analyzing this issue.[3]

The study contributes to the small-business literature in at least three important ways. First, with respect to the literature on business credit scoring, the analysis provides the first

---

[2] In unreported analysis, the D&B credit scores from both the SSBF and KFS are found to be highly correlated with firm age, leverage, profitability, and size as measured by revenues.

[3] Section 1071 of the Dodd-Frank Act of 2010 amended the Equal Credit Opportunity Act to require that financial institutions report information on the credit application of women-owned and minority-owned firms and small businesses. (See 15 USC 1691c-2). However, this information on credit applicants would not provide any data on discouraged firms or firms that did not need credit, which points to the need for a comprehensive nationally representative survey such as the SSBF, which was cancelled by the Federal Reserve Board after the 2003 iteration.

rigorous test of how small-business credit scores differ across four types of firms: no-need borrowers, discouraged borrowers, denied borrowers and successful borrowers; and how credit scores affect the credit-market outcomes of these firms.

Second, the analysis adds to the literature on disparate outcomes in the small-business credit markets by providing new evidence regarding how small-business credit scores affect the availability of credit to small and minority-owned firms. Hence, the results shed new light upon the credit allocation process.

Third, the results contribute to the literature on the availability of credit to small businesses and relationship lending. The study documents how credit scores affect the availability of credit to small businesses, including whether credit scores reduce the importance of relationship lending.

2. LITERATURE REVIEW

The study covers three different strands of the small business literature: credit scoring, relationship lending, and disparate credit-market outcomes. The following is a brief discussion of the seminal and major recent studies in each of these three areas.

2. A. Literature on Credit Scoring and the Availability of Credit

"Credit scoring" refers to a statistical procedure for quantifying the probability of default (PD) for a given entity. Credit scoring has been used in the consumer-credit market for decades, but only began to be applied to small-business credit during the 1990s. Credit scoring is typically modeled as a zero-one outcome in a statistical model such as logistic regression, where a "one" corresponds to a default and a "zero" corresponds to no default. This binary variable is then modeled as a function of variables measuring characteristics of the firm and its primary owner. The most well-known of these models is the FICO model, developed by Fair Isaac and Company

in 1995 based upon sample of several thousand loan applications made at more than a dozen large U.S. banks. Small-business credit scoring (SBCS) began to be adopted by large lenders during subsequent years. The idea behind SBCS is to cut through the opacity of small businesses and standardize the small-business loan application process.

In 1998, the Federal Reserve Bank of Atlanta conducted a survey of 200 of the largest banks in the United States regarding whether and, if so, how they used SBCS. Frame *et al*. (2001) was the first study to analyze these survey data, followed by Akhavein *et al*. (2005).

Berger *et al*. (2011) use data from a survey of 330 primarily small commercial banks conducted by the U.S. Small Business Administration "to address deficiencies in the extant literature" on not only SBCS but also consumer credit scoring (CCS). They find that CCS "plays an especially important role in the evaluation of small business loan applications at community banks." Almost nine out of ten of their sample community banks used the consumer credit score of the firm primary owner *exclusively* in evaluating credit applications; in other words, they did *not* use SBCS in evaluating small business loan applications. These authors also are able to match their survey data to Call Report data on bank nonperforming loans, which they use to investigate "the effect of credit scores on the quality of small business credit." They find that community banks using credit scoring have similar asset quality to banks not using this technology.

In a December (2012a) white paper, the newly established Consumer Financial Protection Bureau (CFPB) provides largely descriptive information on credit reporting by the three largest consumer reporting agencies. While this white paper did not explicitly look at small-business credit scoring, the results of Berger *et al*. (2011) show how important consumer credit scoring is to the availability of small-business credit.

In a related September (2012b) report, the CFPB analyzed credit scores from 200,000 credit files from each of the three major U.S. credit-rating agencies. It found that "for a majority of consumers the scores produced by different credit scoring models provided similar information about the relative creditworthiness of consumers." Correlations across models were generally greater than 0.90. However, it found that different models gave "meaningfully different results" for "a substantial minority" of consumers. In particular, the scores sold to consumers often differed from those sold to prospective lenders.

2. B. Literature on Relationship Lending

The literature on lending relationships rose into prominence following publication of a seminal article by Petersen and Rajan (1994) in *The Journal of Finance*. In that study, the authors analyze data from the 1987 SSBF regarding how firm-lender relationships affect the availability of credit as proxied by the percentage of a firm's trade credits paid late. They find that their proxy is negatively related to both the length of the firm's longest relationship and firm age, and positively related to the number of banks from which the firm borrows.

Since publication of the seminal study by Petersen and Rajan, it has been cited by more than 3,000 articles that appear in the relationship lending literature. Consequently, a comprehensive literature review is beyond the scope of this study, so only the most prominent studies that have analyzed data from the same Federal Reserve Survey of Small Business Finances that are the focus of the analysis will be reviewed. Elyasiani and Goldberg (2004) provide a survey of the relationship literature through 2003.

Berger and Udell (1995) also analyze data from the 1987 SSBF, but focus their analysis on floating-rate lines of credit, arguing that relationships are less important for "transaction-driven" loans, such as mortgages and motor-vehicle loans. This study finds that the loan rates

are negatively related to length of the firm's relationship with its lending bank, and that the age of the firm and the length of the firm's relationship with its lender both decrease the probability that the lender will require collateral to secure the loan.

Avery *et al*. (1998) use data from the 1993 SSBF and the 1995 Survey of Consumer Finances to provide evidence on the importance of personal wealth and personal commitments in small business lending. They find that the majority of small business loans involve a personal commitment, but do not test whether this affects the availability of credit, i.e., whether or not the presence of personal commitments affects the probability of being denied credit.

Cole (1998) uses data from the 1993 SSBF to analyze determinants of the loan approval process, rather than the loan rate or trade credits paid late. This study finds that a lender is more likely to extend credit to a firm with which it has a pre-existing relationship, but that the length of relationship is uninformative. Cole concludes that the role of relationships in the availability of credit is fundamentally different than its role in the pricing of credit.

Petersen and Rajan (2002) focus on the role of distance between a firm and its creditor. They find that the importance of this distance in determining the availability of credit has declined over time, even as the average distance between firms and lenders has increased. They interpret this as evidence of financial sector development in the U.S. small-business loan market.

Cole (2009) develops the three-step sequential model of the credit allocation process used in this study, classifying firms from the 1993, 1998 and 2003 SSBFs as having no need for credit, discouraged from applying for credit, and then being approved or denied should they then apply for credit. Results from this study show that credit-market outcomes are affected by three proxies for relationship lending—the length of the firm's relationship with its prospective lender, its distance from its prospective lender, and the number of banking relationships.

2. C. Literature on Disparate Credit-Market Outcomes

Disparate credit-market outcomes for minority-owned small businesses have been studied by a number of researchers as data, such as the SSBF and KFS, have become available.

Several studies have used SSBF data to analyze how race and gender influence the availability of credit. The first of these was Cavalluzzo and Cavalluzzo (1998), who use data from the 1987 SSBF to find little variation in credit availability by gender but significant differences by race. Cavalluzzo, Cavalluzzo and Wolken (2002) use the more comprehensive data available from the 1993 SSBF to find significant differences in availability of credit by race. Cavalluzzo and Wolken (2005) were the first to examine the impact of race on credit-market outcomes using data from the 1998 SSBF, which provides information on personal wealth—an important omitted variable in earlier analysis. Even when controlling for personal wealth, they continue to find significant differences in credit availability by race.

Robb, Fairlie and Robinson (2009) use data from the KFS to provide new evidence on access of minority-owned start-up firms to financial capital. They find that black-owned firms face significantly greater difficulty in obtaining financial capital than do white-owned firms.

Asiedu, Freeman, and Nti-Addae (2012) use data from the 1998 and 2003 iterations of the SSBF to analyze credit outcomes for female- and minority-owned firms. They conclude from their analysis that black-owned firms faced discrimination in both 1998 and 2003, but worse in 2003; and that Hispanic-owned firms faced discrimination in 1998 but not in 2003. They report finding no evidence of discrimination against firms owned by white females.

Robb (2013) uses data from the KFS to provide evidence on credit market outcomes during 2007–2010 for U.S. start-up firms that were established during 2004 and survived until 2007. Consequently, these results are not representative of all small businesses; instead, they are

representative only of very young startup firms that survived their first three years of operations. Robb finds that, in all four years, minority-owned firms were significantly more likely to be discouraged from applying when they needed credit and were significantly more likely to be denied credit when they did apply. For female-owned firms, she finds that they were significantly more likely to be discouraged during the crisis years of 2008 -2010, but were significantly more likely to be denied only during 2008.

3. DATA

This study uses data both from the Federal Reserve Board's 2003 Survey of Small Business Finances and from the 2008–2010 iterations of the Kauffman Foundation's Kauffman Firm Survey.[4] Each of these two surveys is described briefly below.

In each survey, the key analysis variables are the firm credit score and the race/ethnicity/gender of the firm's primary owner. Information on the race/ethnicity/gender of the firm's controlling owner is used to create indicator variables for female- and minority-owned firms.

Female takes on a value of one if the firm's controlling owner is identified as a female and takes on a value of zero otherwise.

Minority takes on a value of zero if the firm's controlling owner is identified as non-Hispanic white and a value of one otherwise. In other words, *Minority* includes firms whose controlling owner self-identifies as Asian, black, or any other race, or self-identifies as of Hispanic ethnicity. Meaningful analysis of Asian, black, Hispanic and

---

[4] See Elliehausen and Wolken (1990) for a detailed description of the 1987 survey; Cole and Wolken (1995) for a detailed description of the 1993 survey; Bitler, Robb, and Wolken (2001) for a detailed description of the 1998 survey; and Mach and Wolken (2006) for a detailed description of the 2003 survey.

other minorities is simply not possible with the small sample sizes available from the surveys, especially for the analysis of loan denials.

Details on how the firm credit score is defined appear below.

3. A. The 2003 Survey of Small-Business Finances (SSBF)

The SSBF is a nationally representative survey of small businesses operating in the United States as of the year end prior to the survey, where a small business is defined as a nonfinancial, nonfarm enterprise employing fewer than 500 employees.[5] Sponsored by the U.S. Federal Reserve Board, four iterations of the SSBF were conducted by nationally recognized survey research firms—for 1987, 1993, 1998, and 2003. Unfortunately, the Federal Reserve Board chose to terminate the SSBF in 2006, and no viable updates have emerged, so the 2003 iteration remains the most comprehensive source of nationally representative data on small firm finances in the United States. The 2003 SSBF provides data on 4,240 firms that are broadly representative of approximately six million firms operating in the United States as of year-end 2003.[6] Like today, 2003 was a year of economic recovery following the 2001–2002 recession.

The SSBF provides detailed information about each firm's most recent borrowing experience. This includes whether or not the firm applied for credit and, if the firm did not apply, whether it failed to apply because it feared its application would be rejected (discouraged borrowers).

---

[5] The survey design is a complex stratified random sample that utilizes 72 sampling strata defined by cross-classification of four firm size strata, nine census region strata, and two urban/rural strata (4 x 9 x 2 = 72); consequently, it is critically important to use the survey's sampling weights when analyzing the survey data to ensure that results are representative of the target population rather than the nonrandom sample.

[6] Following Cole (2008, 2009, 2010), approximately 460 firms with annual sales or total assets greater than $10 million are deleted so that the results are representative of "small businesses." Also deleted are about 100 firms that are publicly traded firms, have no primary owner (defined by the SSBF as someone who owns at least 10 percent of the firm's equity), and/or whose primary owner is another firm. This leaves an analysis sample of 3,623 firms.

For firms that applied, the SSBF provides information on the identity and characteristics of the potential lender to which the firm applied, other financial services (if any) that the firm obtained from that potential lender, whether the potential lender approved or denied the firm's credit application, and, if the lender extended credit, the terms of the loan.

These data allow for the construction of a number of relationship-lending variables that previous researchers have shown to be important in the availability of credit to small firms. These include the existence of a firm-lender relationship (Cole, 1998); the length of the relationship (Petersen and Rajan, 1994; Berger and Udell, 1995); the distance between the firm and its lender (Petersen and Rajan, 2002); and the number of banking relationships (Bulow and Shoven, 1978).

The survey data also provide information on each firm's balance sheet and income statement; its credit history, including a categorical representation of its D&B credit score; the firm's characteristics, including standard industrial classification (SIC), organizational form, and age; and demographic characteristics of each firm's primary owner, including age, education, experience, and credit history. Balance-sheet and income-statement data are derived from the enterprise's year-end financial statements. Credit history, firm characteristics, and demographic characteristics of each firm's primary owner are taken as of yearend.

Table 1 defines each of the variables created from the 2003 SSBF data; Table 2 presents descriptive statistics for each of these variables; and Table 3 presents a correlation matrix for these variables. Discussion of these descriptive statistics has appeared in a number of publications, such as Cole (2009, 2010), so the reader is referred to those studies. For purposes of this study, it is worth noting from Table 2 that 26.3 percent and 8.8 percent of the firms are classified as female-owned and minority-owned, respectively. With respect to credit market

outcomes, Table 2 shows that 44.2 percent of the 3,623 firms in the final sample reported a need for additional credit. Of these 1,773 firms, 76.2 percent applied for credit while the remaining 23.8 percent reported that they did not apply because they were discouraged and feared rejection. Of the 1,456 firms that applied for credit, 87.0 percent were successful in obtaining credit while the remaining 13.0 percent were denied credit.

Table 3 shows that the D&B categorical credit score has negative correlations of -0.06 and -0.12 with the indicator variables for female-owned and minority-owned firms, respectively, indicating that such firms have lower (worse) credit scores.

Table 1: Definitions of 2003 SSBF Variables

Definition

Credit Outcome Variables

No-Need	The firm reported that it did not need and did not apply for credit during previous three years.
Discouraged	The firm reported that it needed credit but did not apply for credit during previous three years.
Denied	The firm reported that it needed credit during previous three years, applied and was denied credit.

Credit Score Variables

Female Owned	The firm's primary owner is female
Minority Owned	The firm's primary owner is a minority (Asian, black, Hispanic or other non-white)
Credit Score	Categorical representation of the firm's D&B Credit Score.
Score * Female	Interaction of credit score and female-owned.
Score * Minority	Interaction of credit score and minority-owned.

Firm Financials

ln(Sales)	Natural logarithm of the firm's annual sales revenues
ROA	Net income divided by the firm's total assets.
Leverage	Total liabilities divided by the firm's total assets.
Liquidity	Cash and due divided by the firm's total assets.

Firm Characteristics

ln(Firm Age)	Natural logarithm of the firm's age.
Proprietorship	Indicator for firms organized as proprietorships
Urban Location	Indicator for firms domiciled in an urban location.

Owner Characteristics

ln (Experience)	Natural logarithm of the primary owner's business experience (in years).
Graduate Education	Indicator for primary owners with a graduate degree.
College Education	Indicator for primary owners with a college degree.
Personal Wealth	Personal wealth of the primary owner.
Bankruptcy Filer	Indicator that the primary owner had filed bankrutcy during previous three years.

Relationship Variables

Distance to Lender	Distance from the firm's headquarters to the branch of its primary lender where it does business.
Length of Relationship	Length of relationship with the firm's primary financial institution.
Number of Banks	Number of financial institutions with which the firm has relationships.

Table 2: Weighted Descriptive Statistics for 2003 SSBF Variables

Variable	Obs.	Mean	Std.Err.	Min.	Max.
Credit Outcomes					
Need Credit	3,623	0.442	0.008	0	1
Discouraged	1,773	0.238	0.010	0	1
Denied	1,456	0.130	0.009	0	1
Credit Score Variables					
Credit Score	3,623	3.610	0.024	1	6
Female	3,623	0.263	0.007	0	1
Minority	3,623	0.088	0.005	0	1
Firm Financials					
Sales	3,623	624,307	20,027	(2,500)	10,000,000
ROA	3,623	0.607	0.014	-1	2
Leverage	3,623	0.845	0.032	0	12.8
Liquidity	3,623	0.257	0.005	-1	1
Firm Characteristics					
Age (Years)	3,623	14.190	0.181	1	87
Proprietorship	3,623	0.452	0.008	0	1
Urban Location	3,623	0.793	0.007	0	1
Owner Characteristics					
Age (Years)	3,623	51.506	0.190	19	92
Experience (Years)	3,623	19.610	0.194	0	65
Graduate Degree	3,623	0.208	0.007	0	1
College Degree	3,623	0.291	0.008	0	1
Personal Wealth ($M)	3,623	0.700	0.016	-0.3	5
Delinquent	3,623	0.121	0.005	0	1
Industry					
Construction	3,623	0.117	0.005	0	1
Primary Manuf.	3,623	0.031	0.003	0	1
Secondary Manuf.	3,623	0.040	0.003	0	1
Transportation	3,623	0.039	0.003	0	1
Wholesale	3,623	0.057	0.004	0	1
Retail	3,623	0.187	0.006	0	1
Real Estate	3,623	0.067	0.004	0	1
Business Svcs.	3,623	0.253	0.007	0	1
Professional Svcs.	3,623	0.210	0.007	0	1
Relationship Variables					
Distance to Lender (Miles)	3,623			0	3052
Length of Relationship (Months)	3,623			0	1156
Number of Banks	3,623			0	8

Data are from the 2003 Survey of Small Business Finances. Variables are defined in Table 1.

Table 3: Correlation Matrix for 2003 SSBF Variables

	Credit Score	Minority	Female	ln(Sales)	ROA	Leverage	Liquidity	ln(Firm Age)	Proprietor	Urban	ln(Age)	ln(Exper.)	Graduate Education	College Education	Personal Wealth	Personal Delinquency	Personal Bankruptcy	Distance to Lender	Length of Relationship	Number of Banks
Credit Score	1.00																			
Minority	-0.12	1.00																		
Female	-0.06	0.02	1.00																	
ln(Sales)	0.10	-0.04	-0.18	1.00																
ROA	-0.01	0.02	0.01	0.13	1.00															
Leverage	-0.06	0.03	-0.04	-0.02	0.01	1.00														
Liquidity	0.09	0.00	0.06	-0.17	0.25	0.05	1.00													
ln(Firm Age)	0.23	-0.10	-0.09	0.18	0.07	-0.10	-0.04	1.00												
Proprietor	-0.10	0.01	0.09	-0.37	0.13	-0.09	0.08	0.02	1.00											
Urban	-0.03	0.10	-0.02	-0.01	0.06	0.08	0.06	-0.08	-0.08	1.00										
ln(Owner Age)	0.19	-0.06	-0.04	0.01	0.02	-0.02	0.05	0.47	0.00	-0.03	1.00									
ln(Experience)	0.21	-0.09	-0.19	0.18	0.02	-0.05	-0.07	0.65	-0.07	-0.08	0.57	1.00								
Graduate Educ.	0.07	0.04	-0.05	0.01	0.05	0.03	0.10	0.04	-0.02	0.09	0.10	0.01	1.00							
College Educ.	0.01	0.01	-0.03	0.03	0.02	-0.01	0.04	-0.08	-0.07	0.08	-0.01	-0.01	-0.33	1.00						
Personal Wealth	0.14	-0.07	-0.10	0.20	-0.04	-0.12	-0.02	0.19	-0.20	0.02	0.23	0.24	0.10	0.06	1.00					
Personally Delinquent	-0.19	0.09	0.05	-0.04	-0.03	0.09	-0.11	-0.05	0.06	0.04	-0.10	-0.07	-0.03	-0.03	-0.17	1.00				
Personal Bankruptcy	-0.09	0.04	0.04	-0.05	0.01	-0.02	0.01	-0.03	0.07	-0.04	0.00	-0.01	-0.04	-0.02	-0.14	0.13	1.00			
Distance to Lender	-0.03	-0.02	-0.03	0.00	-0.04	0.02	0.01	-0.01	0.00	0.03	0.01	-0.01	0.00	0.00	0.04	0.04	0.03	1.00		
Length of Relationship	0.18	-0.06	-0.02	0.06	0.00	-0.07	0.01	0.51	0.04	-0.13	0.33	0.39	0.01	-0.04	0.10	-0.07	-0.06	-0.08	1.00	
Number of Banks	0.03	0.02	-0.10	0.28	-0.05	0.01	-0.15	0.06	-0.21	-0.02	0.01	0.10	0.01	0.02	0.10	-0.03	-0.02	0.02	-0.01	1.00

Data are from the 2003 Survey of Small Business Finances. Variables are defined in Table 1.

Figure 1 shows the distribution of D&B credit scores for firms in the 2003 SSBF. These credit scores range from zero to 100, with higher scores indicating higher credit quality. The SSBF aggregates firms into six credit-score "buckets." The lowest, bucket 1, corresponds to credit scores of 0 to 10 and contains 9 percent of all small businesses. The second bucket corresponds to credit scores of 11 to 25 and contains 15 percent of all small businesses. The third bucket corresponds to credit scores of 26 to 50 and contains 22 percent of all small businesses. The fourth bucket corresponds to credit scores of 51 to 75 and contains 25 percent of all small businesses. The fifth bucket corresponds to credit scores of 76 to 90 and contains 18 percent of all small businesses. The sixth bucket corresponds to credit scores of 91 to 100 and contains 11 percent of small businesses.

Figure 1: Distribution of D&B Credit Scores among Small Businesses
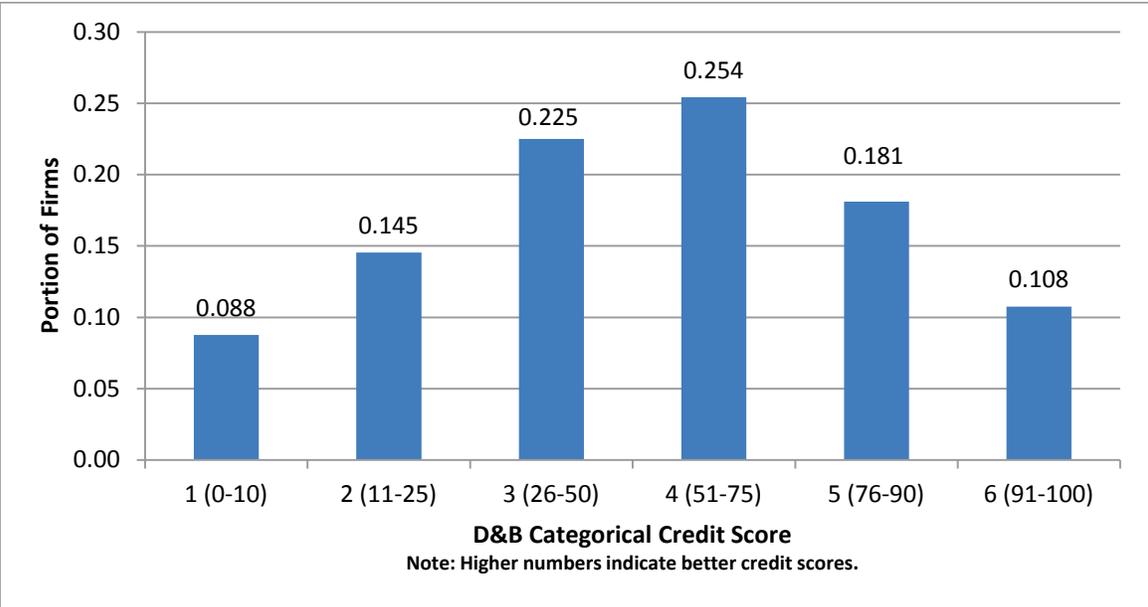
Source: Author's calculations using data from the 2003 Survey of Small Business Finances.

3. B. The Kauffman Firm Surveys

The Kauffman Firm Survey (KFS) is very similar in content to the SSBF, but is representative of a very different population—start-up firms established during 2004. Like the SSBF, the KFS employs a complex stratified random sampling design that oversamples certain types of firms, so once again, it is critically important to incorporate sampling weights into any analysis of the KFS to ensure that inferences can be made to the target population rather than just to the nonrandom sample. The seventh iteration of the KFS tracks firms during the first six years of their operation—from 2004 through 2010. Like the SSBFs, the KFSs provide information on credit scores and credit market outcomes, which make them well suited for the task at hand.

However, because the KFSs are representative only of start-up firms, not all small U.S. firms, one cannot make meaningful inferences from an analysis of KFS firms to the population of U.S. small businesses. Nevertheless, analysis of the KFSs provide an important test of the robustness of results obtained from analyzing the SSBF, the most recent of which was released to the public in 2006 and was based upon information from 2003. Consequently, this study focuses on the most recent iterations of the KFS that provide information from 2008, 2009, and 2010, when the KFS firms had completed four, five, and six years of operations, respectively.[7] Three years are pooled to make the data more comparable with the SSBF, which looks at credit-market

---

[7] There are 3,529 / 2,657 / 2,633 firms that completed the 2008 / 2009 / 2010 iterations of the KFS, respectively, and provided the information needed to create the analysis variables used in this study. Data are pooled over 2008–2010 iterations of the KFS because only about 10 percent of KFS firms apply for credit in any given year, so there are not enough firms to conduct a meaningful analysis of outcomes for a single year of the survey. For example, in 2010, only 213 firms applied for credit, out of which 70 were denied credit and 143 were granted credit. Only 48 of the firms applying for credit in 2010 were minority-owned, of which 22 were denied credit and 26 were granted credit. Only 13 of the firms applying for credit in 2010 were black-owned, of which 7 were denied credit and 6 were granted credit.

outcomes during the previous three years, whereas the KFS looks at credit-market outcomes during the previous year.

Table 4 defines each of the variables created from the KFS data; Table 5 presents descriptive statistics for each of these variables based upon the pooled data from 2008–2010; and Table 6 presents a correlation matrix for these variables.

Table 4: Definitions for 2008-2010 KFS Variables

Definition

Credit Outcome Variables

NoNeed	The firm reported that it did not need and did not apply for credit during the previous year.
Discouraged	The firm reported that it needed credit but did not apply for credit during the previous year.
Denied	The firm reported that it needed credit during the previous year, applied and was denied credit.

Credit Score Variables

Female Owned	The firm's primary owner is female
Minority Owned	The firm's primary owner is a minority (Asian, Black, other race, or Hispanic)
Credit Score	Categorical representation of the firm's D&B Credit Score (1= best, 5 = worst).
Score * Female	Interaction of Credit Score and Female-Owned.
Score * Minority	Interaction of Credit Score and Minority-Owned.

Firm Financials

Size(Sales)	Annual sales revenues (categorical: 1 = smallest, 8 = largest)
Unprofitable	Firm reported a net loss for the year.
Leverage	Total firm debt (business and personal, categorical: 1 = lowest, 8 = highest)
Liquidity	Cash (categorical: 1 = lowest, 8 = highest)

Firm Characteristics

Proprietorship	Indicator for firms organized as proprietorships

Owner Characteristics

ln(Experience)	Natural logarithm of the primary owner's business experience (in years).
ln(Age)	Natural logarithm of the primary owner's age (in years).
Graduate Education	Indicator for primary owners with a graduate degree.
College Education	Indicator for primary owners with a college degree.

Table 5: Weighted Descriptive Statistics for 2008-2010 KFS Variables

Variable	2010 Cross Section						2008-2010 Pooled				
	Obs.	Mean	Std.Err.	Min	Max		Obs.	Mean	Std.Err.	Min	Max
Credit Outcomes											
Need Credit	1,983	0.228	0.009	0	1		8,819	0.246	0.004	0	1
Discouraged	448	0.538	0.024	0	1		1,660	0.516	0.012	0	1
Denied	211	0.371	0.033	0	1		803	0.323	0.017	0	1
Credit Score Variables											
Credit Score	1,983	2.995	0.024	1	5		8,819	2.880	0.011	1	5
Female	1,983	0.253	0.010	0	1		8,819	0.259	0.004	0	1
Minority	1,983	0.302	0.010	0	1		8,819	0.270	0.005	0	1
Firm Financials											
Size(Sales)	1,983	5.578	0.073	0	9		8,819	5.412	0.040	0	9
Leverage	1,983	2.293	0.069	0	9		8,819	2.645	0.032	0	9
Liquidity	1,983	0.545	0.033	0	1		8,819	0.553	0.005	0	1
Unprofitable	1,983	0.306	0.010	0	1		8,819	0.254	0.005	0	1
Firm Characteristics											
Proprietorship	1,983	0.281	0.010	0	1		8,819	0.210	0.004	0	1
Owner Characteristics											
Age	1,983	3.662	0.022	1	7		8,819	3.784	0.010	1	7
Experience	1,983	13.418	0.218	0	40		8,819	13.846	0.094	0	40
College Education	1,983	0.214	0.009	0	1		8,819	0.169	0.004	0	1
Graduate Education	1,983	0.221	0.009	0	1		8,819	0.200	0.004	0	1
Industry											
Agriculture	1,983	0.015	0.003	0	1		8,819	0.015	0.001	0	1
Construction	1,983	0.122	0.007	0	1		8,819	0.121	0.003	0	1
Manufacturing	1,983	0.069	0.006	0	1		8,819	0.064	0.004	0	1
Wholesale	1,983	0.057	0.005	0	1		8,819	0.062	0.002	0	1
Retail	1,983	0.113	0.007	0	1		8,819	0.129	0.003	0	1
Mining	1,983	0.027	0.004	0	1		8,819	0.032	0.002	0	1
Information Svcs.	1,983	0.031	0.004	0	1		8,819	0.031	0.002	0	1
Financial Svcs.	1,983	0.046	0.005	0	1		8,819	0.047	0.002	0	1
Real Estate	1,983	0.061	0.005	0	1		8,819	0.053	0.002	0	1
Professional Svcs.	1,983	0.210	0.009	0	1		8,819	0.202	0.005	0	1
Business Svcs.	1,983	0.086	0.006	0	1		8,819	0.090	0.003	0	1
Health Care	1,983	0.036	0.004	0	1		8,819	0.031	0.002	0	1
Art & Entertainment	1,983	0.028	0.004	0	1		8,819	0.025	0.002	0	1
Food Svcs.	1,983	0.021	0.003	0	1		8,819	0.018	0.001	0	1
Other Svcs.	1,983	0.077	0.006	0	1		8,819	0.076	0.003	0	1

Data are from the 2008 – 2010 iterations of the Kauffman Firm Surveys. Variables are defined in Table 4.

Table 6: Correlation Matrix for 2008-2010 KFS Variables

	Credit Score	Female	Minority	Sales	Leverage	Liquidity	Unprofitable	Proprietor	College Education	Graduate Education	Ln(Exper.)	ln(Owner Age)
Credit Score	1.000											
Female	-0.030	1.000										
Minority	0.15	-0.25	-0.21									
Sales	-0.14	0.16	0.12	1.00								
Leverage	-0.090	0.087	0.064	0.473	1.000							
Liquidity	-0.156	0.205	0.156	0.687	0.367	1.000						
Unprofitable	0.046	0.143	0.145	0.114	0.254	0.171	1.000					
Proprietor	0.021	0.201	0.194	0.088	0.007	0.144	0.124	1.000				
College Educ.	-0.048	0.050	0.053	0.242	0.152	0.251	0.111	0.072	1.000			
Graduate Educ.	-0.102	0.138	0.108	0.256	0.125	0.282	0.126	0.005	-0.216	1.000		
ln(Experience)	-0.01	-0.20	-0.20	-0.05	-0.07	-0.07	-0.10	-0.12	-0.11	0.03	1.00	
ln(Owner Age)	-0.043	-0.096	-0.107	-0.179	-0.115	-0.162	-0.087	-0.075	-0.141	0.058	0.298	1.000

Data are from the 2008 – 2010 iterations of the Kauffman Firm Surveys. Variables are defined in Table 4.

For purposes of this study, it is worth noting from Table 5 that 25.9 percent and 27.0 percent of the firms are classified as female-owned and minority-owned, respectively. With respect to credit-market outcomes, Table 5 shows that 24.6 percent of the 8,819 firm-years in the final sample reported a need for additional credit. Of these 1,660 firms, 48.4 percent applied for credit while the remaining 51.6 percent reported that they did not apply because they were discouraged and feared rejection. Of the 803 firms that applied for credit, 67.7 percent were successful in obtaining credit while the remaining 32.3 percent were denied credit.

Compared with Table 2, minority-owned firms are overrepresented among KFS start-up firms by a factor of three relative to the nationally representative 2003 SSBF; and we see that credit-market outcomes are much worse for the KFS start-up firms. Of the subsample reporting a need for credit, 52 percent of the KFS start-up firms, but only 24 percent of the SSBF firms were discouraged from applying for credit. Among firms that applied, the 32 percent denial rate for KFS firms was two and one-half times the 13 percent denial rate for SSBF firms.

Figure 2 shows the distribution of D&B credit scores for firms in the pooled KFS sample.[8] Again, this credit score ranges from zero to 100, with higher scores indicating higher credit quality. The KFS aggregates firms into five credit-score "buckets." The lowest bucket, bucket 5, corresponds to credit scores of zero to ten and contains 11.0 percent of the start-up firms. The second bucket, bucket 4, corresponds to credit scores of 11 to 30 and contains 8.4 percent of start-ups. Bucket 3 corresponds to credit scores of 31 to 70 and contains 44.6 percent of start-ups. The fourth bucket, bucket 2, corresponds to credit scores of 71 to 90 and contains

---

[8] Distributions of KFS credit scores by year are very similar to the distribution for the pooled sample.

29.4 percent of all small businesses. The fifth bucket, bucket 1, corresponds to credit scores of 91 to 100 and contains only 6.6 percent of start-ups.

Figure 2: Distribution of D&B Credit Scores among Start-up Businesses
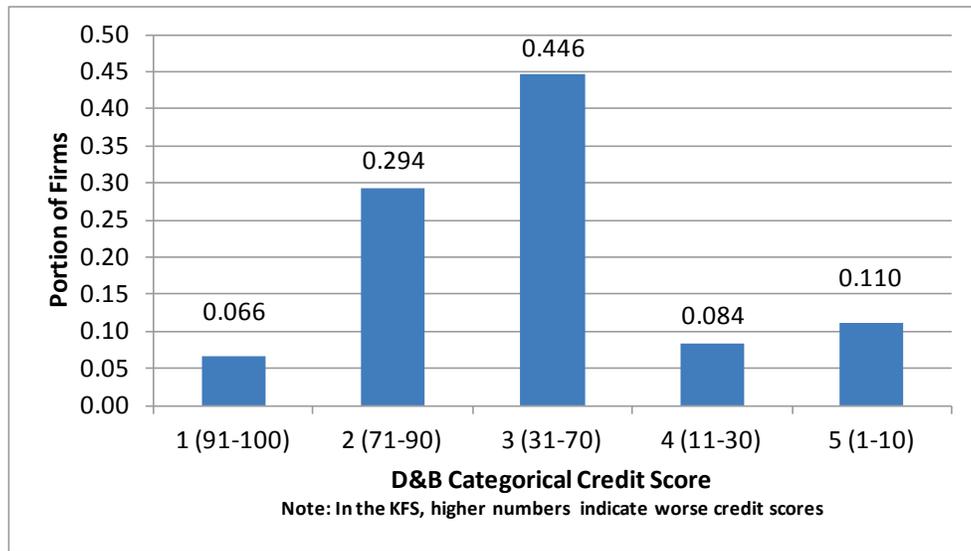
A comparison of Figures 1 and 2 shows large differences in the distributions of the two target populations. In large part, this is due to the different categorization of the D&B credit score used by the KFS, which uses only five buckets rather than the six buckets used by the SSBF, and uses different cutoffs for buckets. For example, bucket 3 covers 40 of the 100 percentile range while, in the SSBF, no bucket covers more than 25 of the 100 percentile range. While the SSBF is close to normally distributed, the KFS has a fat tail of firms with the worst credit scores and much fewer firms with the highest scores.

4. METHODOLOGY

To provide evidence on whether credit scoring has affected relationship lending and adversely affected credit-market outcomes of female-owned and minority-owned firms, this study presents graphs and analyzes the data using both univariate and multivariate test methodologies.

4. A. Univariate Tests and Graphs

First, firms are classified into one of four mutually exclusive categories of *Borrower Type* based upon their responses to questions regarding their most recent loan request during the previous three years.

(1) No-need borrower: the firm did not apply for a loan during the previous year (KFS)/three years (SSBF) because the firm did not need additional credit.[9]

(2) Discouraged borrower: the firm did not apply for a loan during the previous year because the firm feared rejection.[10]

(3) Denied borrower: the firm did apply for a loan during the previous three years but was denied credit by its prospective lender.

(4) Successful borrower: the firm did apply for a loan during the previous three years and was granted credit by its prospective lender.

Once firms are classified into this firm sample, descriptive statistics are calculated and credit scores plotted across different categories. Of special interest is the D&B credit rating variable.

---

[9] Note that the majority of these firms have borrowed funds more than three years before the survey so that they do have outstanding debt in their capital structure. One interpretation is that these firms have reached their optimal capital structure.

[10] A small number of firms reported they were discouraged, but also reported that they applied for credit. These firms are classified as denied or successful borrowers based upon the outcome of their application, rather than as discouraged. See Cole (2009) for details.

As shown in Figure 3, 44 percent of the 2003 SSBF firms reported that they needed credit while 56 percent reported that they did not need credit. Of the 44 percent that needed credit, 76 percent applied for credit while 24 percent were discouraged and did not apply, fearing rejection. Of the 76 percent of firms that applied for credit, 87 percent were successful in obtaining credit while 13 percent were denied credit.

Figure 3: A Sequential Model of Who Needs and Who Gets Credit
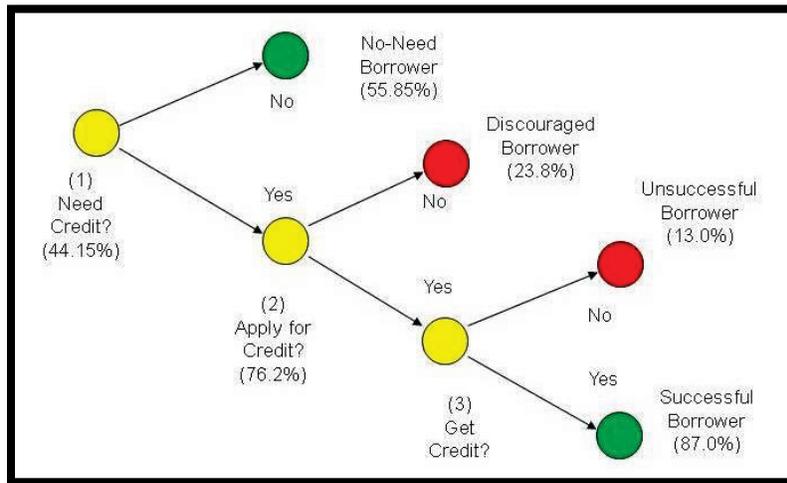
Source: Authors calculations using data from the 2003 Survey of Small Business Finances.

4. B. Multivariate Tests

Multivariate tests of the data follow Cole (2009) in using a three-stage sequential logistic regression model to explain the sequential selection of the loan application and approval process (Figure 3). Logistic regression is used because all three dependent variables (*Need Credit, Discouraged,* and *Denied*) are binary, i.e., each takes on a value of zero or one, so that key assumptions of the standard ordinary-least-squares regression model are violated. (See Maddala (1983), pp. 15–16.) While probit regression would be equally valid for analyzing these dependent variables, logistic regression has an advantage relative to probit regression in that its coefficients can be converted into odds ratios, which are easier to understand than the marginal effects of a probit model.

As shown in Figure 3, a firm first decides whether or not it needs credit. This analysis includes all four groups of firms. A value of zero is assigned to firms reporting that they didn't need credit and a value of one to firms reporting that they did need credit.

Second, a firm that needs credit decides whether or not to apply for credit. *No-need* borrowers are excluded from this stage of the model; a value of one is assigned to *Discouraged* borrowers and a value of zero to *Denied* borrowers and *Approved* borrowers. *Credit Score* is included in this model because many, if not most, firm owners are aware of their firm's credit score, and the owner's knowledge of a low credit score may discourage a firm's owner from applying. Relationship variables are included in this model because owners of firms with stronger relationships with their prospective lenders would be expected to be more likely to apply for credit rather than to be discouraged from applying.

Third, a firm that decides to apply for credit is either successful or unsuccessful in obtaining credit, i.e., it is approved for or denied credit by its prospective lender. Included in this

stage of the model are only those firms that applied for credit; a value of one is assigned to

borrowers who were denied credit and a value of zero to borrowers who were approved for credit

by their prospective lenders. Here, *Credit Score* is included to test its impact on the likelihood of

obtaining credit. The relationship variables are included to test whether they are significant

predictors of credit market outcomes as documented in studies using data from the three earlier

iterations of the SSBF. *Credit Score* is interacted with the indicator variables *Female-owned* and

Minority-owned to test whether the credit scores have a disparate outcome on such firms. Finally,

the model is estimated with and without the credit-score variable to test whether credit scores

reduce or eliminate the importance of the relationship variables in predicting credit-market

outcomes. A more detailed discussion of the three statistical models appears in Appendix 2.

Results are presented showing odds ratios rather than coefficients or marginal effects for

ease of interpretation.[11] Positive coefficients produce odds ratios greater than one, whereas

negative coefficients produce odds ratios of less than 1.00 (but bounded below by 0.00).[12]

To control for observable differences in minority-owned and nonminority-owned firms,

each model includes three vectors of control variables: firm characteristics, owner characteristics

---

[11] The output from a logistic regression typically includes a coefficient estimate and standard error for each explanatory variable (as well as some goodness-of-fit statistics for the entire model). Because logistic (and probit) regression models require an arbitrary scaling of coefficients, they cannot be interpreted in the same manner as standard OLS coefficients. However, by exponentiating (i.e., raising Euler's transcendental number (e ~ 2.718) to the power of) a logistic regression coefficient, which is a log-odds ratio, one obtains a simple odds ratio that has a very simple intuitive interpretation—the change in the odds of observing a value of one for the dependent variable given a one-unit change in the explanatory variable, where 1.00 indicates even odds (i.e., no effect of the explanatory variable on the dependent variable)

[12] For example, a coefficient of 0.4055 on the explanatory variable Minority-owned in the logit regression explaining loan denials would correspond to an odds ratio of exp (0.4055) = 1.50, and, depending on the robustness of the data, could indicate that a minority-owned firm is 50 percent more likely to be denied credit when it applies, or conversely, that it is 33 percent less likely to be approved when it applies, than is a white-owned firm. For continuous variables, the odds ratio measures the change in odds for a one-unit change in the continuous explanatory variable. For example, a coefficient of -0.105 on Credit Score in explaining loan denials would correspond to an odds ratio of exp(10.105) = 0.90, indicating that a one-category increase in the firm's credit rating, say from 5 to 4, could reduce the probability of denial by 10 percent, or conversely, could increase the likelihood of approval by 11 percent.

and firm-lender relationship characteristics. The literature on the availability of credit to small businesses has established that these control variables are usually significant in explaining credit market outcomes. For example, Cole (2009) reports that a firm is more likely to be denied credit when it is smaller, when it is less liquid, and when it is organized as a proprietorship; and is more likely to be discouraged from applying for credit when it is younger, smaller, more highly levered, and less profitable. Cole (2009) also reports that a firm is more likely to be denied credit when its primary owner is less educated or has reported being delinquent on personal obligations; and is more likely to be discouraged when its primary owner has less personal wealth. Moreover, a firm is more likely to be denied when it has more banking relationships and is more likely to be discouraged when it has a shorter relationship with its primary source of financial services. Therefore, it is important to include each of these variables as controls when analyzing credit-market outcomes. A detailed description of the control variables appears in Appendix 3. Relationship characteristics are available only for the SSBF, not for the KFS.

4. C. Hypotheses regarding Ownership, Relationship Lending, and Credit Scoring

The primary hypotheses relate to the impact of minority ownership, relationship lending, and credit scores on credit-market outcomes in equations (2), (3) and (4).

> *H0*: A minority-owned firm is more likely to need credit; is more likely to be discouraged from applying for credit; and is more likely to be denied credit when it applies for credit.[13]

> *H1*: A firm with stronger relationships with its lender is less likely to need credit; less likely to be discouraged; and less likely to be denied.[14]

---

[13] This implies that (C < 0) in equations (1), (2), and (3).
[14] This implies that (G > 0) in equations (1), (2) and (3).

H2: A firm with a higher credit score is less likely to need credit; is less likely to be

discouraged from applying for credit, even when the firm needs credit; and is less

likely to be denied credit when it applies for credit.[15]

H3: The impact of the credit score on the likelihood of needing credit, discouragement,

and denial is stronger/weaker for a female-owned/minority-owned firm than for a

firm owned by a non-Hispanic white male.[16]

H4: The impact of relationship variables on credit market outcomes is

weakened/eliminated by consideration of the firm's credit score.[17]

Hypotheses regarding other differences in successful and unsuccessful borrowers are well

documented in the literature. (See, e.g., Cole 1998; Cole, Goldberg and White 2004; Cole 2009;

Robb 2013).

The tests use the credit-score variable, a set of dummy variables, and a set of credit-

score/dummy-variable interaction terms to capture differences in credit market outcomes. Each

of the three logistic regression models includes a set of binary indicator variables for *Female-*

Owned and for *Minority-Owned* firms, and another set of the same indicator variables interacted

with the *Credit Score*.[18]

---

[15] This implies that (B < 0) in equations (1), (2), and (3).

[16] If minority-owned firms are more aware of their credit scores than nonminority-owned firms, then the interaction terms would be expected to be positive in eq. (2); whereas if minority-owned firms are less aware of their credit scores, then the interaction terms would be expected to be negative in eq. (2).

Similarly, if lenders pay more attention to credit scores of minority-owned firms, the interaction terms would be expected to be positive in equations (1) and (3); whereas, if lenders pay less attention to credit scores of minority-owned firms, then the interaction terms would be expected to be negative in equations (1) and (3).

This implies that (D > 0/D < 0) in equations (1), (2), and (3).

If minority-owned and nonminority-owned firms are treated equally based upon their credit scores, then insignificant coefficients would be expected in equations (1), (2), and (3).

This implies that (D = 0) in equations (1), (2) and (3).

[17] This implies that the absolute magnitude of G is significantly smaller when *Credit Score* is included in the model.

[18] The indicator variables for female-owned and minority-owned firms are interacted with the categorical credit score rather than the set of credit-score dummy variables because such interactions would produce extremely small cell counts, especially among minority-owned firms.

5. RESULTS

5. A. Univariate Results

Figure 4 presents the distribution of non-Hispanic white-owned firms and minority-owned firms by the categorical representation of the D&B credit score used by the 2003 SSBF. As in Figure 1, categories 1 through 6 correspond to D&B credit scores of 0-10, 11-25, 26-50, 51-75, 76-90, and 91-100, respectively, where higher scores represent higher creditworthiness.

Figure 4: Distribution of 2003 SSBF Credit Scores by Minority Status
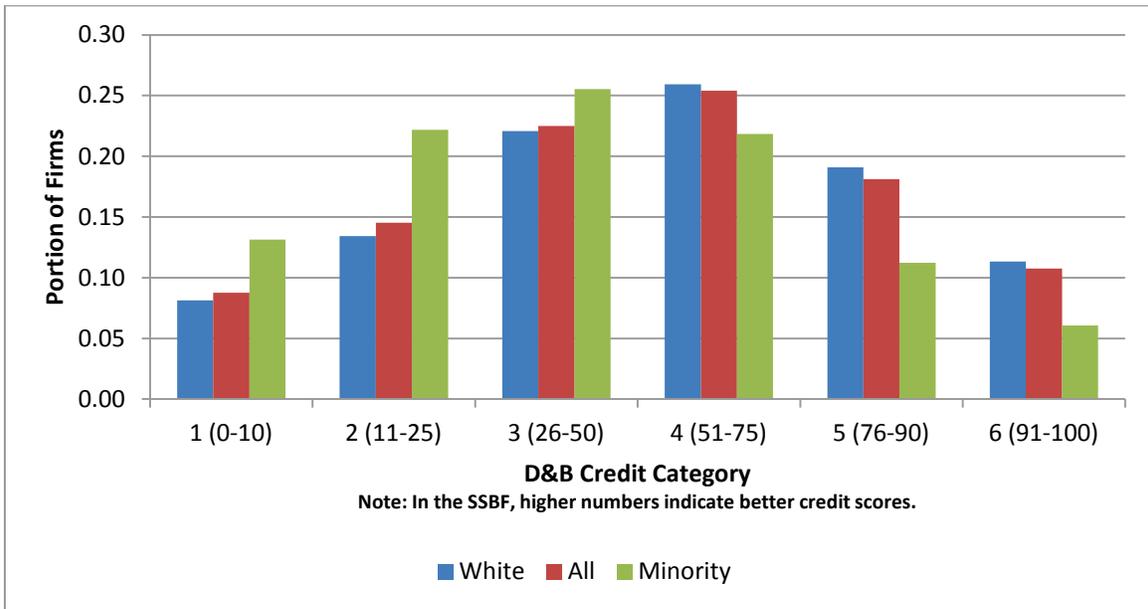
Source: Author's calculations using data from the 2003 Survey of Small Business Finances

As shown in Figure 4, the distribution of credit scores for non-Hispanic white-owned firms is very similar to the distribution of all firms, which is unremarkable because non-Hispanic white-owned firms account for about 88 percent of the firms. However, in each of the three highest credit-quality categories, non-Hispanic white-owned firms are overrepresented while in the three lowest credit-quality categories, they are underrepresented. In contrast, minority-owned firms are seriously overrepresented in the three lowest credit-quality categories and seriously underrepresented in the three highest credit-quality categories.

Figure 5: Distribution of 2003 SSBF Credit Scores by Gender
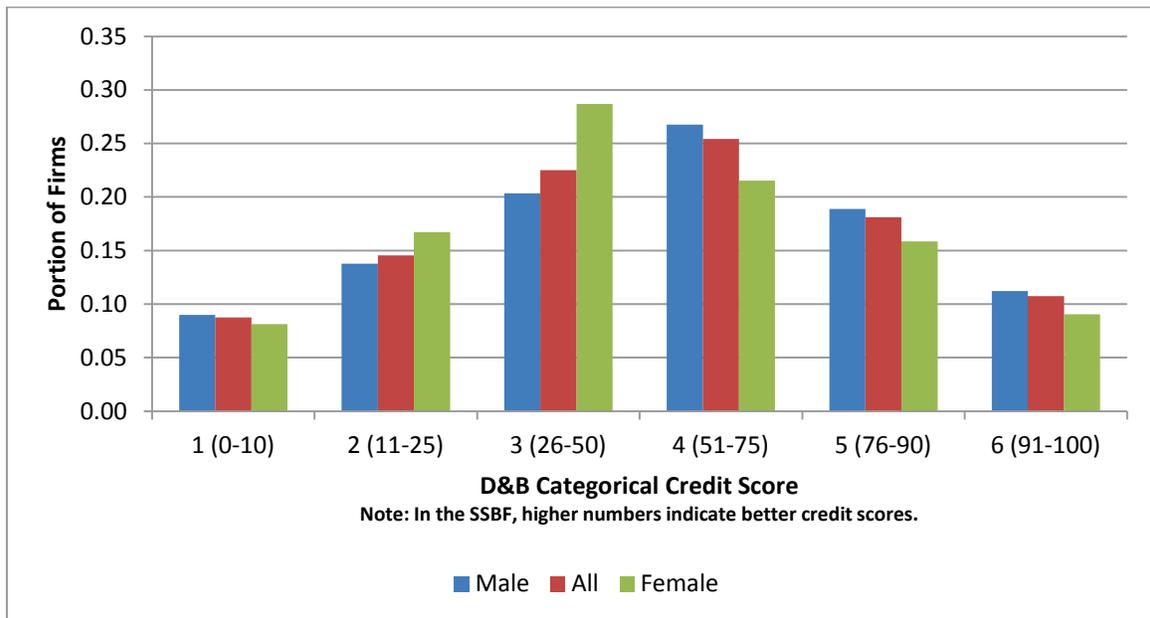
Source: Author's calculations using data from the 2003 Survey of Small Business Finances.

Figure 5 presents the distribution of male- and female-owned firms by D&B categorical credit rating. Male-owned firms are disproportionately represented in each of the three highest credit-quality categories, but also in the very lowest one. Consequently, female-owned firms are underrepresented in these same four categories and overrepresented in the remaining two.

Figure 6 presents the distribution of *Denied* and *Discouraged* firms by D&B categorical credit rating. A *Denied* firm is one that applied for credit and was turned down by its prospective lender. A *Discouraged* firm is one that said it needed credit but did not apply because it feared it would be turned down. Denied firms are seriously underrepresented in the three highest credit-quality categories, slightly underrepresented in the third lowest category, and seriously overrepresented in each of the two lowest credit-quality categories, as we would expect. Discouraged firms are seriously underrepresented in the two highest credit-quality categories and seriously overrepresented in the two lowest credit-quality categories, but are represented in the two middle credit-quality categories at about the same percentages as all firms.

Figure 6: Distribution of 2003 SSBF Credit Scores by Credit Market Outcome
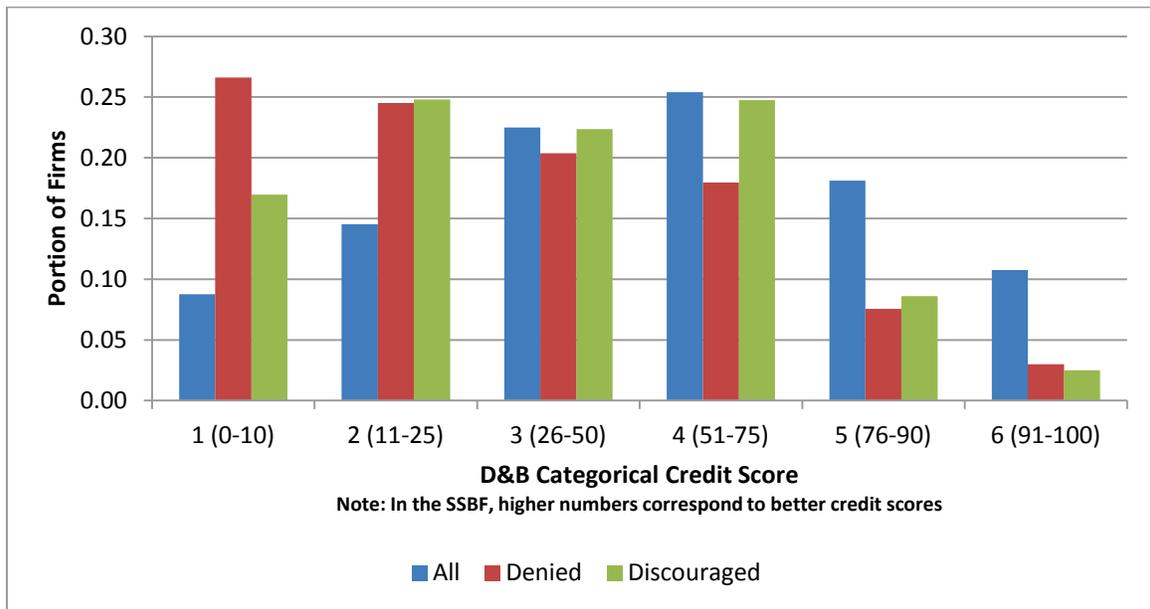
Source: Author's calculations using data from the 2003 Survey of Small Business Finances

For the 2003 SSBF, Figure 7 shows the credit-market outcomes of all firms, and, separately, the disparate outcomes for non-Hispanic white male-owned firms, female-owned firms, Asian-owned firms, black-owned firms, and Hispanic-owned firms. Clearly visible are the disproportionate credit-market outcomes experienced by minority-owned firms. While only 44.3 percent of non-Hispanic white male-owned firms reported a need for additional credit, 48.9 percent of Hispanic-owned firms and 57.2 percent of black-owned firms reported such a need. Of the firms reporting a need for credit, only 17.8 percent of non-Hispanic white male-owned firms reported discouragement, while 30.8 percent of Hispanic-owned firms, 36.8 percent of female-owned firms, and 44.6 percent of black-owned firms reported discouragement. Of the firms that actually applied for credit, only 10.8 percent of non-Hispanic white male-owned firms reported being denied credit, while 14.8 percent of female-owned, 16.5 percent of Hispanic-owned, and a staggering 66.6 percent of black-owned firms reported being denied credit.

Figure 7: Distribution of 2003 SSBF Credit Market Outcomes
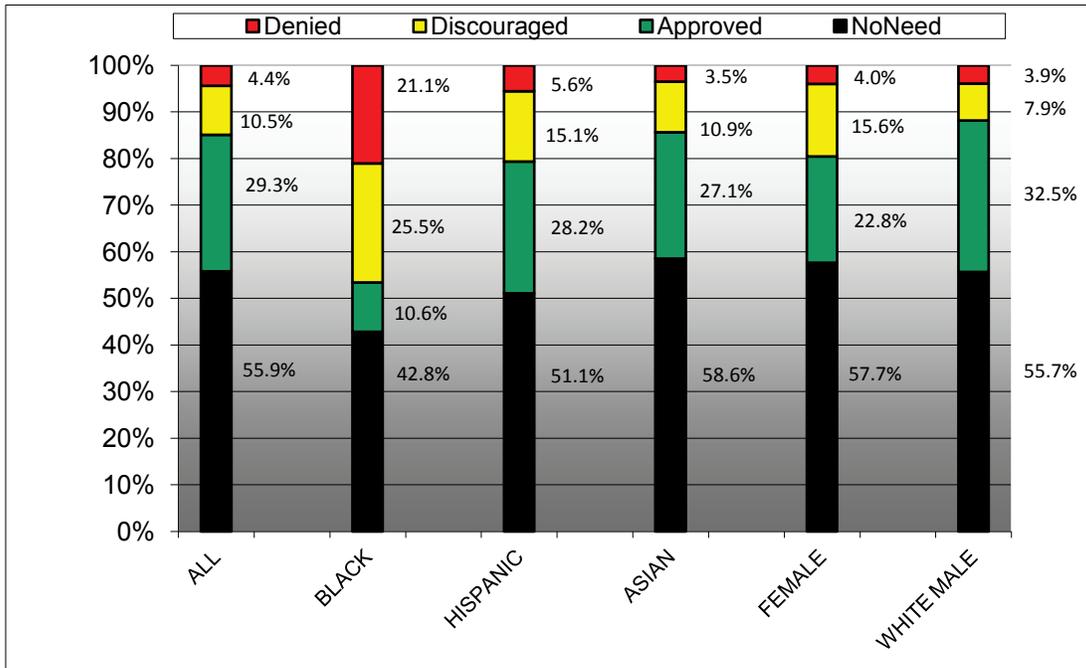
Source: Author's calculations using data from the 2003 Survey of Small Business Finances

Figure 8: Distribution of 2008-2010 KFS Credit Market Outcomes
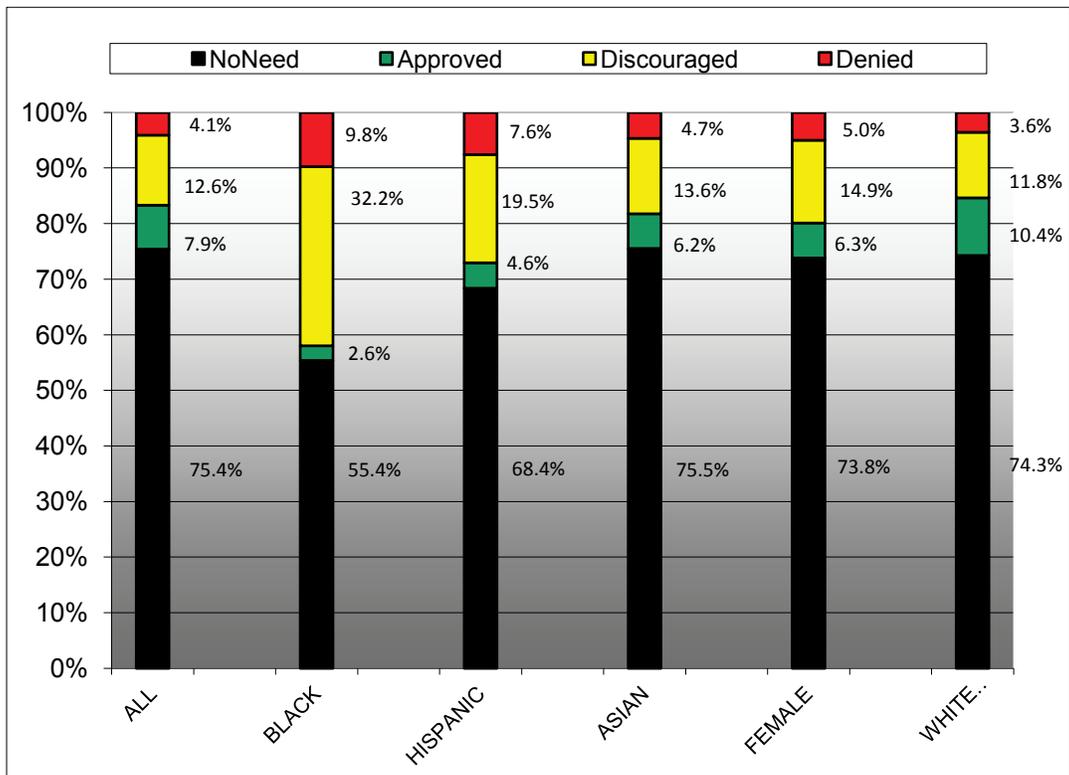
Source: Author's calculations using pooled data from the 2008-2010 Iterations of the Kauffman Firm Survey

For the 2008-2010 iterations of the KFS, Figure 8 shows the credit-market outcomes of all firms and, separately, the disparate outcomes for non-Hispanic white male-owned firms, female-owned firms, Asian-owned firms, black-owned firms, and Hispanic-owned firms. As was true with the SSBF, the disproportionate credit-market outcomes experienced by minority-owned firms are also clear in the KFS, but, in general, all KFS firms experienced worse credit market outcomes than SSBF firms. It is not possible to tell if this is because of the much worse credit market conditions in 2008-2010 or because of the lower creditworthiness of start-up firms, or some combination of the two.

While only 25.7 percent of non-Hispanic white male-owned firms reported a need for additional credit, 31.6 percent of Hispanic-owned firms and 44.6 percent of black-owned firms reported such a need. Of the firms reporting a need for credit, 45.9 percent of non-Hispanic white male-owned firms reported discouragement, but 56.9 percent of female-owned firms, 61.5 percent of Hispanic-owned firms, and 72.3 percent of black-owned firms reported discouragement. Of the firms that actually applied for credit, 25.5 percent of non-Hispanic white male-owned firms reported being denied credit, but 44.1 percent of female-owned firms, 62.3 percent of Hispanic-owned firms, and 78.8 percent of black-owned firms reported being denied credit.

Figure 9 shows the average categorical credit scores by industry based upon the 2003 SSBF. There is wide variation in the average across industries. Real estate has the highest (best) average score at 4.2; followed by construction at 3.8; secondary manufacturing, professional services, and wholesale trade at 3.7; primary manufacturing and transportation at 3.6. Business services and retail trade have the worst average credit scores at 3.4.

Figure 9: Average SSBF 2003 Categorical Credit Scores by Industry
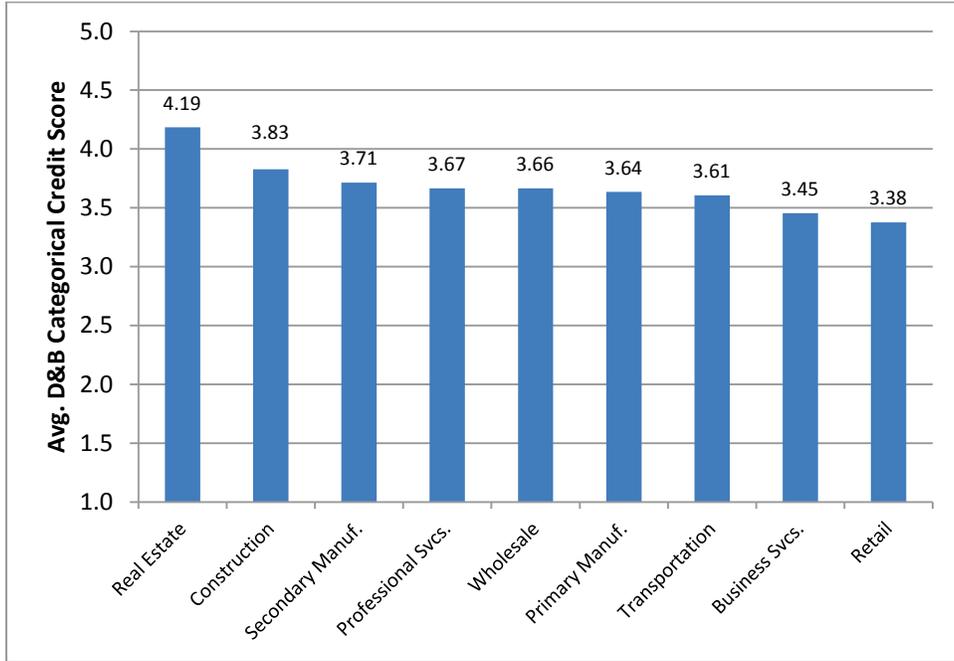
Source: Author's calculations using data from the 2003 Survey of Small Business Finances.
Note: In the SSBF, higher numbers indicate better credit scores

Figure 10: Average 2003 SSBF Categorical Credit Scores by Firm Age
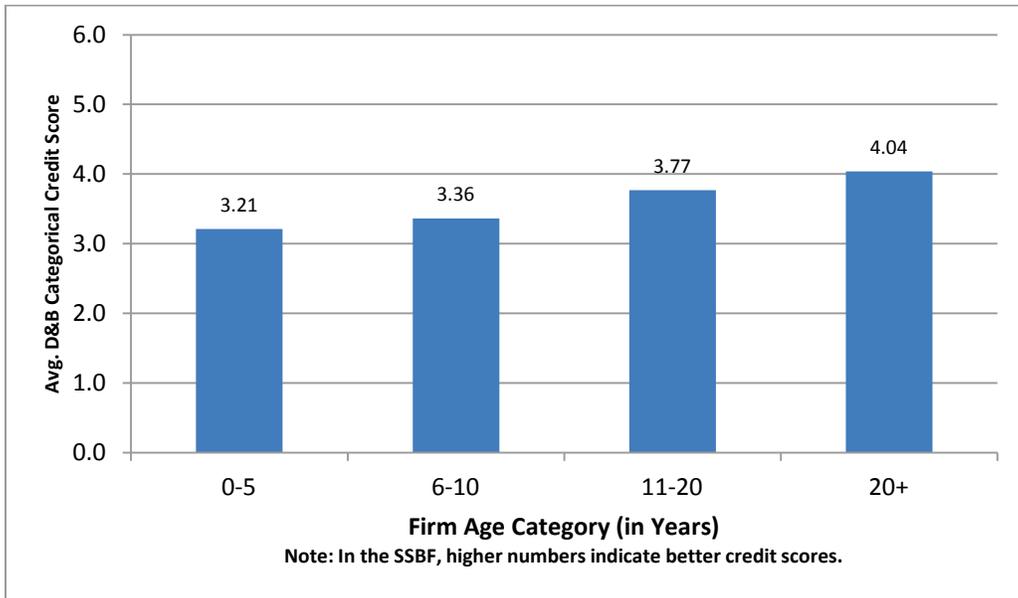
Source: Author's calculations using data from the 2003 Survey of Small-Business Finances.

Figure 10 demonstrates why use of the KFS to analyze credit scores is problematic by examining average categorical credit scores by firm age. KFS follows start-up firms during their first six years of operation. As shown in Figure 10, firms less than six years old have significantly lower credit scores than do older firms. In spite of this shortcoming, the KFS data are used as a test of the robustness of the findings using the 2003 SSBF data.

Figure 11: Distribution of 2008-2010 KFS Categorical Credit Scores by Minority Status
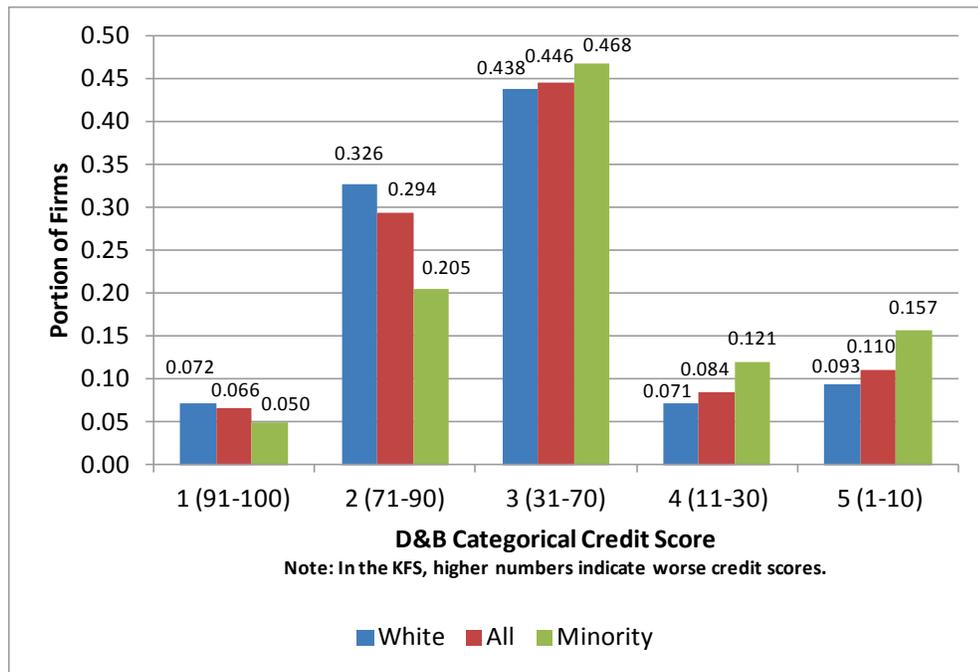

Source: Author's calculations using pooled data from 2008 - 2010 Iterations of the Kauffman Firm Surveys.
Note: In the KFS, lower numbers correspond to better credit scores

Figure 11 shows the distribution of credit scores by minority status (non-Hispanic white-owned firms, all firms, and minority-owned firms) based upon the pooled 2008-2010 KFS data. The differences in non-Hispanic white-owned firms and minority-owned firms are similar to those observed in Figure 4 for SSBF firms: non-Hispanic white-owned firms are overrepresented in the two highest credit-score categories (1–2) while minority-owned firms are overrepresented in the three lowest categories (3–5).

Figure 12: Distribution of 2008-2010 KFS Categorical Credit Scores by Industry

Figure 12 shows the average scores by industry based upon the 2010 iteration of the KFS. There is wide variation in the average across industries. Mining has the highest (worst) average credit score at 3.8, followed by art & entertainment at 3.3; retail, construction, manufacturing, and other services at 3.1; health care, financial services, and business services at 3.0; food services, information services, and professional services , and wholesale trade at 2.8. Real estate and agriculture have the lowest (best) average credit score at 2.7.

5. B. Multivariate Results from the SSBF

Tables 7–9 present the results from using data from the 2003 SSBF to estimate the three-equation sequential logistic regression model, where the first equation explains whether or not

the firm needed credit; the second equation explains whether or not a firm that needed credit was discouraged from applying for credit; and the third equation explains whether or not a firm that applied for credit was denied.

Each table provides results from six different specifications of equation (1), with explanatory variables added in sequence, to show how adding different groups of variables affects the simple model without any controls. This iterative fitting procedure helps one to understand why credit scores that are significant in explaining credit outcomes lose significance when all of the control variables are included in a particular outcome model.

First, only the credit score, gender and minority status are included to see if there is an observable disparate impact of the credit score on female-owned or minority-owned firms. A set of dummies is used for each credit score category to test whether there is a threshold above which scores do not matter for credit market outcomes. Interactions with *Female* and *Minority* use the categorical credit score to avoid very sparsely populated interaction terms.

Next, variables are added to test whether any observable significant relations are the result of spurious correlations with other firm or owner characteristics. For example, one might observe that female-owned firms are more likely to be denied credit and that female-owned firms are smaller than male-owned firms. When firm size is added to the model, smaller firms are shown to be significantly more likely to be denied credit, but the coefficient on the indicator female-owned firms loses statistical significance. In other words, in this hypothetical, the true factor driving denials is firm size rather than gender.

5. B. 1. Firms with No Need for Credit (SSBF Firms)

Table 7 presents the results from a logistic regression model that explains whether or not a firm reported that it did not need credit at any time during the previous three years. Scanning from left to right, one sees that the credit score variables are important in explaining the need for credit, but that this importance disappears as one adds the full set of control variables. In other words, the control variables do a better job of explaining the need for credit than do the credit score variables. In particular, the firm financial variables (size, profitability, leverage, and liquidity) are extremely important in this model, as are several of the primary owner's characteristics (age, education, personal wealth, delinquency on personal credit obligations, and previous bankruptcy) and the three measures of relationship lending.

Firms are more likely to need credit when they are larger and more highly levered and are less likely to need credit when they are more profitable and more liquid. A firm is more likely to need credit when its primary owner reports delinquencies on personal credit obligations and a previous bankruptcy and is less likely to need credit when its primary owner is older, better educated, and has greater personal wealth. A firm is more likely to need credit when it has more banking relationships and when it is located farther away from its prospective lender and is less likely to need credit when it has a longer preexisting relationship with its prospective lender.

5. B. 2. Applied for Credit vs. Discouraged from Applying for Credit (SSBF Firms)

Table 8 presents the results from a logistic regression model that explains whether or not a firm reported that it needed credit at any time during the previous three years but failed to apply because it was discouraged. Again, the same six specifications are tested. Scanning from left to right, one sees that the credit score variables are important in explaining discouragement, but that, as was true for the need for credit, this importance disappears as one adds the full set of

control variables. In other words, the control variables do a better job of explaining discouragement than do the credit score variables. In particular, the firm size is extremely important in this model, as are several of the firm's characteristics (age, legal form of organization, and urban/rural location), several of the primary owner's characteristics (personal wealth, delinquency on personal credit obligations, and previous bankruptcy), and two of the three measures of relationship lending (length of relationship and number of relationships).

A firm is less likely to be discouraged from applying for credit when it is larger and older, and is more likely to be discouraged when it is organized as a proprietorship rather than a corporation and when it is located in an urban rather than a rural area. A firm is more likely to be discouraged when its primary owner reports delinquencies on personal credit obligations and a previous bankruptcy and is less likely to be discouraged when its primary owner has greater personal wealth. A firm is less likely to be discouraged when it has a longer pre-existing relationship with its prospective lender and when it has more banking relationships.

5. B. 3. Approved for Credit vs. Denied Credit (SSBF Firms)

Table 9 presents the results from a logistic regression model that explains whether or not a firm reported that it applied for and was denied credit at any time during the previous three years. Again, the same six specifications are tested. Scanning from left to right, one sees that the credit score variables are important in explaining loan denials, but that, as was true for the need for credit and discouragement, this importance (mostly) disappears as one adds the full set of control variables. The one notable exception is the indicator for the worst categorical credit score (*Credit Score 1*), which remains statistically significant even in the presence of the full set of control variables. The odds ratio indicates that a firm with the worst categorical credit score is

more than three times more likely to be denied credit than a firm with the best categorical credit score.

In addition, many of the control variables are important in explaining the loan-denial decision. In particular, minority ownership, firm size, and firm leverage are extremely important in this model, as are several of the primary owner's characteristics (education, delinquency on personal credit obligations, and previous bankruptcy) and one of the three measures of relationship lending (number of relationships).

A firm is more likely to be denied credit when it is minority owned by an order of magnitude relative to a firm owned by a non-Hispanic white. A firm is more likely to be denied credit when it is more highly levered and is less likely to be denied credit when it is larger. A firm is more likely to be denied credit when its primary owner reports delinquencies on personal credit obligations and a previous bankruptcy and is less likely to need credit when its primary owner is more educated. A firm is more likely to be denied credit when it has more banking relationships.

Table 7: Logistic Regression Results for Need Credit vs. No-need SSBF Firms

Variables	Odds Ratio	t-Stat		Odds Ratio	t-Stat		Odds Ratio	t-Stat		Odds Ratio	t-Stat		Odds Ratio	t-Stat		Odds Ratio	t-Stat	
Credit Score Variables																		
Credit Score 1	2.44	3.99	***	2.10	3.29	***	2.08	3.19	***	1.57	1.95	*	1.47	1.56				
Credit Score 2	1.46	2.03	**	1.68	2.68	**	1.54	2.17	**	1.28	1.22		1.20	0.85				
Credit Score 3	1.16	0.89		1.43	2.12	**	1.36	1.78	*	1.22	1.12		1.19	0.95				
Credit Score 4	1.15	0.96		1.27	1.57		1.23	1.36		1.11	0.66		1.05	0.29				
Credit Score 5	0.94	-0.37		1.03	0.21		1.03	0.20		0.99	-0.05		0.96	-0.26				
Female Owned	1.11	0.39		1.48	1.32		1.42	1.19		1.24	0.74		1.36	1.01		1.11	0.93	
Score * Female	0.94	-0.89		0.93	-0.95		0.94	-0.88		0.96	-0.59		0.94	-0.77				
Minority Owned	0.78	-0.62		0.81	-0.48		0.84	-0.40		0.68	-0.90		0.65	-1.02		1.00	0.00	
Score * Minority	1.10	0.83		1.10	0.79		1.08	0.67		1.13	1.04		1.13	1.10				
Firm Financials																		
ln(Sales)				1.20	6.05	***	1.19	5.17	***	1.22	4.80	***	1.18	4.14	***	1.17	4.21	***
ROA				0.81	-3.74	***	0.83	-3.13	***	0.82	-3.39	***	0.83	-3.19	***	0.83	-3.09	***
Leverage				1.19	5.77	***	1.19	5.62	***	1.17	5.23	***	1.16	5.44	***	1.16	5.45	***
Liquidity				0.23	-8.03	***	0.23	-8.04	***	0.27	-7.00	***	0.29	-6.48	***	0.28	-6.75	***
Firm Characteristics																		
ln(Firm Age)							0.85	-3.12	***	0.95	-0.72		1.02	0.26		1.01	0.08	
Proprietorship							0.88	-1.15		0.77	-2.16	**	0.81	-1.78	*	0.82	-1.66	*
Urban Location							0.81	-1.85	*	0.84	-1.48		0.82	-1.70	*	0.82	-1.70	*
Owner Characteristics																		
ln(Age)										0.39	-3.49	***	0.41	-3.30	***	0.40	-3.43	***
ln(Experience)										1.05	0.50		1.06	0.55		1.06	0.54	
Graduate Education										0.80	-1.77	*	0.78	-1.97	**	0.77	-2.12	**
College Education										0.80	-2.02	**	0.79	-2.08	**	0.78	-2.14	**
Personal Wealth										0.92	-3.55	***	0.91	-3.88	***	0.91	-3.94	***
Personally Delinquent										2.55	5.69	***	2.58	5.73	***	2.69	6.06	***
Personal Bankruptcy Filer										2.38	2.33	**	2.21	2.09	**	2.27	2.16	**
Relationship Variables																		
Distance to Lender													1.00	2.54	**	1.00	2.58	**
Length of Relationship													1.00	-2.80	***	1.00	-2.83	***
Number of Banks													1.51	6.33	***	1.51	6.31	***

The dependent variable *Need Credit* takes on a value of one if the firm reported that it needed credit (applied for credit during the previous three years and was either extended or denied credit, or needed credit but was discouraged and did not apply for credit) and a value of zero if the firm reported that it did not need (or apply for) credit during the previous three years. Results are from a binary logistic regression model that incorporates sampling weights and sampling strata. Data are from the 2003 SSBF. Variables are defined in Table 1. Not shown in the last four models are eight industry dummies.

***, ** and * indicate statistical significance at the 0.01, 0.05 and 0.10 levels, respectively.

Table 8: Logistic Regression Results for Discouraged vs. Applied SSBF Firms

Variables	Odds Ratio	t-Stat		Odds Ratio	t-Stat		Odds Ratio	t-Stat		Odds Ratio	t-Stat		Odds Ratio	t-Stat		Odds Ratio	t-Stat	
Credit Score Variables																		
Credit Score 1	4.43	3.48	***	4.33	3.16	***	3.78	2.83	***	2.33	1.60		1.92	1.33				
Credit Score 2	4.74	4.00	***	3.23	2.71	***	2.54	2.17	**	1.83	1.30		1.43	0.86				
Credit Score 3	2.94	3.01	***	1.96	1.62		1.53	1.03		1.16	0.34		0.94	-0.16				
Credit Score 4	2.92	3.12	***	2.45	2.33	**	2.09	1.91	*	1.69	1.28		1.43	0.97				
Credit Score 5	1.39	0.89		0.93	-0.16		0.90	-0.24		0.83	-0.42		0.68	-0.93				
Female Owned	2.66	2.41	**	2.18	1.84	*	1.95	1.54		1.54	0.96		1.68	1.12		1.54	2.25	**
Score * Female	0.95	-0.43		0.95	-0.43		0.98	-0.18		1.01	0.08		0.98	-0.18				
Minority Owned	1.03	0.06		0.65	-0.79		0.53	-1.10		0.32	-2.07	**	0.32	-2.06	**	0.95	-0.20	
Score * Minority	1.24	1.39		1.35	1.84	*	1.32	1.65		1.44	2.24	**	1.44	2.28	**			
Firm Financials																		
ln(Sales)				0.72	-4.54	***	0.78	-3.87	***	0.80	-4.38	***	0.81	-3.92	***	0.83	-3.61	***
ROA				1.17	1.52		1.13	1.10		1.12	0.97		1.07	0.61		1.08	0.66	
Leverage				1.05	1.21		1.05	1.01		1.01	0.16		1.01	0.15		1.01	0.23	
Liquidity				1.75	1.61		1.62	1.38		1.91	1.86	*	1.97	2.00	**	1.77	1.73	*
Firm Characteristics																		
ln(Firm Age)							0.66	-4.45	***	0.66	-3.36	***	0.77	-1.95	*	0.75	-2.13	**
Proprietorship							1.99	3.47	***	1.57	2.23	**	1.61	2.30	**	1.63	2.38	**
Urban Location							1.67	2.34	**	1.81	2.50	**	1.82	2.39	**	1.87	2.56	**
Owner Characteristics																		
ln(Age)										0.65	-0.91		0.75	-0.63		0.79	-0.51	
ln(Experience)										1.13	0.70		1.17	0.89		1.17	0.89	
Graduate Education										0.73	-1.22		0.72	-1.27		0.71	-1.36	
College Education										0.82	-0.91		0.82	-0.93		0.82	-0.91	
Personal Wealth										0.88	-3.17	***	0.88	-3.22	***	0.88	-3.26	***
Personally Delinquent										3.67	6.09	***	3.49	5.81	***	3.78	6.54	***
Personal Bankruptcy Filer										4.31	3.41	***	4.24	3.40	***	4.34	3.51	***
Relationship Variables																		
Distance to Lender													1.00	-0.36		1.00	-0.35	
Length of Relationship													1.00	-3.71	***	1.00	-3.79	***
Number of Banks													0.69	-2.94	***	0.70	-2.88	***

The dependent variable *Discouraged from Applying for Credit* takes on a value of zero if the firm applied for credit with the previous three years and was extended or denied credit and a value of one if the firm needed credit but was discouraged and did not apply for credit during the previous three years. Results are from a binary logistic regression model that incorporates sampling weights and sampling strata. Data are from the 2003 SSBF. Variables are defined in Table 1. Not shown in the last four models are eight industry dummies.

***, ** and * indicate statistical significance at the 0.01, 0.05 and 0.10 levels, respectively.

Table 9: Logistic Regression Results for Denied vs. Approved SSBF Firms

Variables	Odds Ratio	t-Stat		Odds Ratio	t-Stat		Odds Ratio	t-Stat		Odds Ratio	t-Stat		Odds Ratio	t-Stat		Odds Ratio	t-Stat	
Credit Score Variables																		
Credit Score 1	5.09	3.18	***	5.07	3.16	***	5.03	3.15	***	3.67	2.53	**	3.29	2.20	**			
Credit Score 2	3.39	2.47	**	3.02	2.21	**	2.82	1.99	**	2.31	1.52		2.04	1.27				
Credit Score 3	1.77	1.24		1.55	0.95		1.49	0.83		1.20	0.37		1.09	0.16				
Credit Score 4	1.60	1.08		1.64	1.12		1.59	1.05		1.58	1.00		1.40	0.70				
Credit Score 5	0.95	-0.12		0.92	-0.18		0.91	-0.20		0.97	-0.06		0.83	-0.37				
Female Owned	1.92	1.14		1.79	1.03		1.91	1.12		1.76	0.83		1.81	0.85		0.89	-0.37	
Score * Female	0.81	-1.21		0.81	-1.23		0.80	-1.32		0.77	-1.34		0.77	-1.29				
Minority Owned	10.98	3.27	***	10.58	3.10	***	10.02	3.02	***	8.90	2.84	***	8.66	2.89	***	4.60	4.42	***
Score * Minority	0.80	-1.02		0.79	-1.05		0.78	-1.11		0.78	-1.06		0.78	-1.03				
Firm Financials																		
ln(Sales)				0.88	-3.15	***	0.87	-2.90	***	0.88	-2.38	**	0.86	-2.67	***	0.88	-2.31	**
ROA				1.03	0.17		1.04	0.24		1.05	0.30		1.05	0.32		1.13	0.77	
Leverage				1.14	3.19	***	1.13	2.82	***	1.12	2.42	**	1.13	2.50	**	1.12	2.36	**
Liquidity				0.60	-1.18		0.60	-1.15		0.56	-1.30		0.62	-1.06		0.44	-1.87	*
Firm Characteristics																		
ln(Firm Age)							0.85	-1.13		0.83	-0.98		0.90	-0.52		0.89	-0.57	
Proprietorship							0.81	-0.79		0.65	-1.46		0.67	-1.33		0.78	-0.83	
Urban Location							1.33	0.96		1.45	1.17		1.39	1.03		1.52	1.31	
Owner Characteristics																		
ln(Age)										0.83	-0.28		0.79	-0.36		0.66	-0.68	
ln(Experience)										1.00	0.01		1.01	0.06		1.04	0.16	
Graduate Education										0.35	-2.79	***	0.33	-2.88	***	0.30	-3.13	***
College Education										0.78	-0.93		0.73	-1.17		0.63	-1.72	*
Personal Wealth										0.94	-1.29		0.94	-1.11		0.95	-0.92	
Personally Delinquent										3.34	4.02	***	3.44	4.04	***	4.10	4.85	***
Personal Bankruptcy Filer										4.87	2.74	***	4.70	2.69	***	6.00	2.91	***
Relationship Variables																		
Distance to Lender													1.00	0.47		1.00	0.57	
Length of Relationship													1.00	-1.36		1.00	-1.60	
Number of Banks													1.30	1.99	**	1.29	2.03	**

The dependent variable *Denied Credit* is a binary variable equal to zero if the firm applied for and was extended credit during the previous three years and a value of one if the firm applied for and was denied credit during the previous three years. Results are from a binary logistic regression model that incorporates sampling weights and sampling strata. Data are from the 2003 SSBF. Variables are defined in Table 1. Not shown in the last four models are eight industry dummies.

***, ** and * indicate statistical significance at the 0.01, 0.05 and 0.10 levels, respectively.

5. C. Multivariate Results from the KFS

Tables 10–12 present the results from using pooled data from the 2008–2010 iterations of the KFS to estimate the three-equation sequential logistic regression model, where the first equation explains whether or not the firm needed credit; the second equation explains whether or not the firm needed credit but was discouraged from applying for credit; and the third equation explains whether or not the firm was denied credit, conditional upon applying for credit. In the KFS, the credit score is in the reverse order from the SSBF, so that higher values indicate worse, rather than better, credit scores. For each credit-market outcome, only four different specifications are tested because the KFS does not provide information on firm-lender relationships.

5. C. 1. No Need for Credit (KFS Firms)

Table 10 presents the results from a logistic regression model that explains whether or not a firm reported that it needed credit at any time during the previous year. Scanning from left to right, one sees that the credit score variables are important in explaining the need for credit, but that this importance disappears as one adds the full set of control variables, just as was true in the analysis of the SSBF data. As with the SSBF analysis, the firm financial variables (size, profitability, and leverage) are extremely important in this model. Two of the primary owner's characteristics (age and education) are marginally important.

Firms are more likely to need credit when they are larger and more highly levered and are less likely to need credit when they are profitable. These results mirror what was found analyzing the SSBF data. A firm is more likely to need credit when its primary owner is better educated and is less likely to need credit when its primary owner is older. The former finding is contrary to the SSBF results, while the latter is consistent with them.

Variables	Odds Ratio	t-Stat.		Odds Ratio	t-Stat.		Odds Ratio	t-Stat.		Odds Ratio	t-Stat.	
Credit Score Variables:												
Credit Score 5	1.188	0.67		1.806	2.07	**	1.779	2.05	**	1.751	1.97	**
Credit Score 4	1.034	0.14		1.346	1.16		1.324	1.11		1.349	1.16	
Credit Score 3	0.465	-4.16	***	0.745	-1.47		0.741	-1.52		0.728	-1.59	
Credit Score 2	0.619	-2.79	***	0.882	-0.66		0.893	-0.61		0.926	-0.41	
Female	0.788	-0.76		0.824	-0.59		0.868	-0.43		0.885	-0.35	
Credit Score * Female	1.134	1.24		1.135	1.13		1.127	1.07		1.097	0.78	
Minority	1.219	0.65		1.097	0.28		1.104	0.29		1.012	0.03	
Credit Score * Minority	0.905	-1.07		1.046	0.43		1.044	0.41		1.080	0.71	
Firm Financials:												
Sales				1.110	5.85	***	1.107	5.74	***	1.101	5.22	***
Leverage				1.290	15.61	***	1.289	15.39	***	1.294	15.13	***
Liquidity				0.858	-1.18		0.868	-1.10		0.848	-1.24	
Unprofitable				2.214	7.78	***	2.217	7.75	***	2.214	7.58	***
Firm Characteristics:												
Proprietorship							1.020	0.17		1.106	0.81	
Owner Characteristics:												
College Degree										0.992	-0.05	
Graduate Degree										1.334	1.88	*
ln(Experience)										1.033	0.50	
ln(Age)										0.708	-1.79	*

The dependent variable *Need Credit* takes on a value of one if, during the previous year, the firm reported that it needed credit (applied for credit and was either extended or denied credit, or needed credit but was discouraged and did not apply for credit) and a value of zero if, during the previous year, the firm reported that it did not need (and did not apply for) credit. Results are from a Stata survey binary logistic regression model that incorporates panel sampling weights and sampling strata. Pooled data are from the 2008, 2009, and 2010 iterations of the Kauffman Firm Survey. Variables are defined in Table 4. Not shown in the last two models are 14 industry dummies. ***, ** and * indicate statistical significance at the 0.01, 0.05, and 0.10 levels, respectively.

5. C. 2. Discouraged from Applying for Credit (KFS Firms)

Table 11 presents the results from a logistic regression model that explains whether or not a firm reported that it needed credit at any time during the previous year, but failed to apply because it was discouraged and feared rejection. The same four specifications are tested. Scanning from left to right, one sees that the credit score variables are important in explaining discouragement, but unlike results for previous models, this importance remains strong as one adds the full set of control variables. In the final specification, the odds ratios of indicators for each of the three worst categorical credit scores are highly significant and indicate that firms

with these ratings are twice, three times, and four times more likely to be discouraged than are firms with the best categorical credit rating.

Table 11: Logistic Regression Results for Discouraged vs. Applied KFS Firms

Variables	Odds Ratio	t-Stat.		Odds Ratio	t-Stat.		Odds Ratio	t-Stat.		Odds Ratio	t-Stat.	
Credit Score Variables:												
Credit Score 5	6.050	4.43	***	4.609	3.70	***	4.899	3.93	***	4.162	3.55	***
Credit Score 4	3.600	3.23	***	2.821	2.56	**	2.826	2.51	**	3.124	2.72	***
Credit Score 3	3.200	3.65	***	2.385	2.65	***	2.158	2.49	**	2.042	2.25	**
Credit Score 2	2.008	2.21	**	1.774	1.75	*	1.576	1.45		1.462	1.19	
Female	0.848	-0.31		0.861	-0.28		0.710	-0.66		0.798	-0.42	
Credit Score * Female	1.197	1.06		1.148	0.79		1.190	1.05		1.153	0.83	
Minority	1.831	1.10		1.774	0.98		1.941	1.20		1.809	1.04	
Credit Score * Minority	1.009	0.05		0.970	-0.17		0.955	-0.27		0.966	-0.19	
Firm Financials:												
Sales				0.906	-3.21	***	0.931	-2.20	**	0.929	-2.19	**
Leverage				0.922	-3.11	***	0.937	-2.44	**	0.929	-2.65	***
Liquidity				0.693	-1.76	*	0.803	-1.01		0.775	-1.16	
Unprofitable				1.718	3.08	***	2.149	4.27	***	2.151	4.17	***
Firm Characteristics:												
Proprietorship							3.449	6.00	***	3.216	5.61	***
Owner Characteristics:												
College Degree										0.959	-0.20	
Graduate Degree										0.742	-1.27	
ln(Experience)										0.945	-0.59	
ln(Age)										0.893	-0.35	

The dependent variable *Discouraged from Applying for Credit* takes on a value of zero if, during the previous year, the firm needed and applied for credit and either was extended or denied credit; and a value of one if, during the previous year, the firm needed credit but was discouraged and did not apply for credit. Results are from a Stata survey binary logistic regression model that incorporates panel sampling weights and sampling strata. Pooled data are from the 2008, 2009, and 2010 iterations of the Kauffman Firm Survey. Variables are defined in Table 4. Not shown in the last two models are 14 industry dummies.
***, **, and * indicate statistical significance at the 0.01, 0.05, and 0.10 levels, respectively.

Among the control variables, firm financials (size, leverage, and profitability) are extremely important, as is the indicator for firms organized as proprietorships; but none of the owner characteristics are important in determining discouragement, including gender and minority status.

A firm is less likely to be discouraged from applying for credit when it is larger, profitable, and more highly levered, and is more likely to be discouraged when it is organized as

a proprietorship rather than a corporation. The findings for firm size and legal form of organization are consistent with those from analysis of the SSBF data.

5. C. 3. Approved for Credit vs. Denied Credit (KFS Firms)

Table 12 presents the results from a logistic regression model that explains whether or not a firm reported that it applied for and was denied credit at any time during the previous three years. Scanning the table reveals that only a few variables are important in this model, and even those are only marginally important. At least in part, this reflects the much higher rate of loan denials in the KFS data for all firms. Whereas only 13 percent of SSBF firms applying for credit were denied, the denial rate among KFS firms is almost three times as high at 34 percent. Only the odds ratio on the indicator for firms with the worst categorical credit score is statistically significant in any of the four specifications. However, its magnitude is consistently greater than 2.0, indicating that firms with the worst categorical credit score are more than twice as likely to be denied credit than are firms with the best categorical credit score.

Only three variables show up as significant in the fully specified denial model at even the 0.10 level (leverage, liquidity and owner age) and none of these are significant at the 0.05 level. A more levered firm is more likely to be denied credit, while a more liquid firm and a firm with an older primary owner is less likely to be denied credit.

It is important to note that the odds ratios on the two minority variables are jointly significant, indicating that minority-owned firms are about half again as likely to be denied credit as a firm owned by a non-Hispanic white. Indeed, when only the indicator for minority ownership is included in these models, i.e., when the interaction of minority ownership with the credit score is included, the odds ratio on *Minority* is statistically significant at better than the

0.05 level and also indicates that a minority-owned firm is half again as likely to be denied credit as a firm owned by a non-Hispanic white.

Table 12: Logistic Regression Results for Denied vs. Approved KFS Firms

Variables	Odds Ratio	t-Stat.		Odds Ratio	t-Stat.		Odds Ratio	t-Stat.		Odds Ratio	t-Stat.	
Credit Score Variables:												
Credit Score 5	2.81	1.95	*	2.45	1.60		2.22	1.30		2.19	1.29	
Credit Score 4	2.09	1.38		1.87	1.13		1.88	1.08		1.57	0.74	
Credit Score 3	0.93	-0.18		0.83	-0.44		0.79	-0.53		0.84	-0.40	
Credit Score 2	0.96	-0.11		0.94	-0.16		0.93	-0.18		0.86	-0.39	
Female	1.93	0.99		1.62	0.68		1.87	0.84		1.74	0.67	
Credit Score * Female	1.06	0.22		1.09	0.31		1.10	0.33		1.03	0.08	
Minority	1.12	0.15		1.06	0.07		1.42	0.41		1.51	0.48	
Credit Score * Minority	1.54	1.70		1.54	1.63		1.42	1.22		1.42	1.20	
Firm Financials:												
Sales				0.91	-1.96	**	0.93	-1.61		0.93	-1.41	
Leverage				1.05	1.22		1.07	1.44		1.09	1.91	*
Liquidity				0.63	-1.49		0.57	-1.77	*	0.55	-1.69	*
Unprofitable				1.31	1.00		1.29	0.91		1.53	1.48	
Firm Characteristics:												
Proprietorship							1.27	0.67		1.24	0.56	
Owner Characteristics:												
College Degree										1.04	0.10	
Graduate Degree										1.11	0.29	
ln(Experience)										0.86	-1.17	
ln(Age)										0.46	-1.80	*

The dependent variable *Denied Credit* is a binary variable equal to zero if, during the previous year, the firm applied for and was extended credit; and a value of one if, during the previous year, the firm applied for and was denied credit. Results are from a Stata survey binary logistic regression model that incorporates panel sampling weights and sampling strata. Pooled data are from the 2008, 2009, and 2010 iterations of the Kauffman Firm Survey. Variables are defined in Table 4. Not shown in the last two models are 14 industry dummies.
***, ** and * indicate statistical significance at the 0.01, 0.05, and 0.10 levels, respectively.

6. SUMMARY, CONCLUSIONS, AND POLICY IMPLICATIONS

This study provides the first comprehensive documentation of how credit scores affect the ability of female-owned and minority-owned (Asian, black, Hispanic and other) small businesses to access credit, based upon the 2003 SSBF and the 2010 KFS. It also provides new evidence on how credit scores do, or do not, attenuate the importance of relationship lending.

This new evidence enables us to determine if credit scoring has had a disparate impact on the access of female- and minority-owned firms to credit, and whether this impact, if any, arises through discouraging such firms from borrowing or through the credit allocation decision of lenders. By comparing the results with respect to relationship lending to those from studies of earlier SSBFs, such and Cole (1998) and Cole, Goldberg and White (2004), the new evidence sheds new light on whether the importance of relationship lending has diminished over time. It has not.

Analysis of data from the 2003 SSBF shows that minority-owned firms are disproportionately denied credit when they need, and apply, for additional credit—strong evidence that is consistent with the existence of taste-based discrimination in the small-business loan market. Analysis of both the SSBF data and the KFS also shows that business credit scores are important at all three steps of the model. Firms with worse business credit scores are: (i) more likely to need additional credit because their credit needs have not been met by past borrowings; (ii) more likely to be discouraged from applying for credit when they report a need for additional credit; and (iii) more likely to be denied credit when they need additional credit and apply for credit. However, the significance of the business credit score in these models disappears when a comprehensive set of control variables for firm characteristics, owner characteristics, and firm lender relationships is included, with the notable exception of KFS discouragement. This is unremarkable because Dun & Bradstreet is likely to utilize these same or similar control variables in calculating the business credit scores that are tested in this study. Moreover, there is no evidence in this analysis that business credit scores have a disproportionately adverse effect on the availability of credit either to (i) female-owned firms

relative to male-owned firms or (ii) to minority-owned firms relative to white-owned firms. Nor is there any evidence that credit scores reduce the importance of firm-lender relationships.

The study provides both academics and policymakers with new insights on how to tailor macroeconomic policies and regulations to help female-owned and minority-owned small businesses obtain needed credit at the best possible terms and reach their optimal capital structures. Specifically, the results demonstrate that minority-owned firms have experienced credit-market outcomes inferior to those experienced by non-Hispanic white-owned firms. The higher rates of loan denials are consistent with the existence of taste-based discrimination by lender. However, this study is based upon datasets that lack critical information that is available to lenders, such as the income-tax records of loan applicants. This points to the need for more focused research on this issue using more comprehensive sources of data, including tax records.

The higher rates of discouragement among minority-owned and female-owned firms may point to the need for better outreach regarding the credit underwriting process and in building social capital and networks between the financial community and minority-owned and female-owned firms. In such an environment, had these firms applied for loans, a significant portion may have been successful in obtaining credit.

It is important to note limitations of this study. First, only the D&B business credit score is analyzed, yet surveys have found that lenders use other business credit scores, and use consumer credit scores when underwriting loans to small businesses. This study can only speak to the impact of D&B business credit scores on credit-market outcomes; the impact of consumer credit scores and other business credit scores might have different effects on credit-market outcomes. Second, the SSBF database used in this study is now a decade old, predating the 2008 financial crisis. In the current environment, even the D&B credit score may have different effects

on credit market outcomes. It is for this reason that the study also looks at data from the 2008-2010 KFS, but those data can only be used to make inferences about start-up firms, which have much worse credit-market outcomes than established firms. Unfortunately, there are no better databases currently available for analyzing this issue.

Section 1071 of the Dodd-Frank Act of 2010 amends the Equal Credit Opportunity Act to require that financial institutions collect and report information on credit applications by small businesses, especially those that are owned by minorities and by women. Once this information becomes publicly available, researchers will be able to examine credit market outcomes using much more timely data than what is used in this study. However, even this new source of data has many serious limitations. It will only provide information about firms that actually apply for loans, so no information will be available on firms that do not apply, including discouraged firms. This points to the critically important need for a nationally representative survey of small businesses like the SSBF, which was cancelled by the Federal Reserve Board after its 2003 iteration.

REFERENCES

Akhavein, J., Frame, W. S., White, L. J. 2005. The Diffusion of Financial Innovation: An Examination of the Adoption of Small Business Credit Scoring by Large Banking Organizations. *Journal of Business* 78, 577-596.

Asiedu, E., Freeman, J., Nti-Addae, A. 2012. Access to Credit by Small Businesses: How Relevant Are Race, Ethnicity, and Gender? *American Economic Review* 102, 532-537.

Avery, R,. Bostic, R., Samolyk, K. 1998. The Role of Personal Wealth in Small Business Finance. *Journal of Banking & Finance* 22, 1019-1061.

Bates, T. 1997. Unequal Access: Financial Institution Lending to Black- and White-Owned Small Business Start-ups. *Journal of Urban Affairs* 19, 487-495.

Becker, G., 1957. *The Economics of Discrimination*. Chicago: University of Chicago Press.

Berger, A., Cerqueiro, G., Penas, M. 2011. Does Debtor Protection Really Protect Debtors? Evidence from the Small Business Credit Market. *Journal of Banking & Finance* 35, 1843-1857.

Berger, A., Cowan, A., Frame, S. 2011. The Surprising Use of Credit Scoring in Small Business Lending by Community Banks and the Attendant Effects on Credit Availability, Risk, and Profitability. *Journal of Financial Services Research* 39, 1-17.

Berger, A., Udell, G. 1995. Relationship Lending and Lines of Credit in Small Firm Finance. *Journal of Business* 68, 351-381.

Berger, A., Udell, G. 1998. The Economics of Small Business Finance: The Roles of Private Equity and Debt Markets in the Financial Growth Cycle. *Journal of Banking & Finance* 22, 613-673.

Berger, A. Frame, S. 2007. Small Business Credit Scoring and Credit Availability. *Journal of Small Business Management* 45, 5-22.

Berger, A., Frame, W.S., Miller, N. 2005a. Credit Scoring and the Availability, Price, and Risk of Small Business Credit. *Journal of Money, Credit & Banking* 37, 191-222.

Berger, A., Espinosa, M., Frame, S., Miller, N. 2005b. Debt, Maturity, Risk, and Asymmetric Information. *The Journal of Finance* 2895-2923.

Bitler, M., Robb, A., Wolken, J. 2001. Financial Services Used by Small Businesses: Evidence from the 1998 Survey of Small Business Finances. *Federal Reserve Bulletin* 87 (Apr.), 183-205.

Blanchard, L, Zhao, B, Yinger, J. 2008. Do Lenders Discriminate Against Minority and Woman Entrepreneurs? *Journal of Urban Economics* 63, 467-497.

Blanchflower, D., Levine, P., Zimmerman, D. 2003. Discrimination in the Small Business Credit Market. *Review of Economics and Statistics* 84, 930-943.

Bulow, J., Shoven, J., 1978. The Bankruptcy Decision. *Bell Journal of Economics* 9, 437-456.

Cavalluzzo, K., Cavalluzzo, L. 1998. Market Structure and Discrimination: The Case of Small Businesses. *Journal of Money, Credit & Banking* 30, 771-92.

Cavalluzzo, K., Cavalluzzo, L., Wolken, J. 2002. Competition, Small Business Financing, and Discrimination: Evidence from a New Survey. *Journal of Business* 75, 641-679.

Cavalluzzo, K., Wolken, J. 2005. Small Business Loan Turndowns, Personal Wealth and Discrimination. *Journal of Business* 78, 2153-2178.

Chakraborty, A., Hu, C. 2006. Lending Relationships in Line-of-Credit and Non-Line-of-Credit Loans: Evidence from Collateral Use in Small Business. *Journal of Financial Intermediation* 15, 86-107.

Chakravarty, S., Yilmazer, T. 2009. A Multistage Model of Loans and the Role of Relationships. *Financial Management* 38, 781-816.

Cole, R. 1998. The Importance of Relationships to the Availability of Credit. *Journal of Banking & Finance* 22, 959-997.

Cole, R. 1999. Availability of Credit to Small and Minority-Owned Businesses: Evidence from the Survey of Small Business Finances, Available at: http://ssrn.com/abstract=1007077 .

Cole, R. 2009. Who Needs Credit and Who Gets Credit? Evidence from the Surveys of Small Business Finances. In *Small Business in Focus: Finance.* U.S. Small Business Administration Office of Advocacy, Research Summary No. 348.

Cole, R. 2010. *Bank Credit, Trade Credit or No Credit? Evidence from the Surveys of Small Business Finances.* U.S. Small Business Administration Office of Advocacy, Research Summary No. 365.

Cole, R., Goldberg, L. and White, L. 2004. Cookie-Cutter versus Character: The Micro Structure of Small-Business Lending by Large and Small Banks. *Journal of Financial & Quantitative Analysis* 39, 227-251.

Cole, R., Mehran, H. 2011. Gender and the Availability of Credit: Evidence from the Surveys of Small Business Finances. FRB-NY Working Paper No. 383.

Cole, R., Wolken, J., 1995. Financial Services Used by Small Businesses: Evidence from the 1993 National Survey of Small Business Finances. *Federal Reserve Bulletin* 81 (Jul.), 630-67.

Coleman, S. 2002. The Borrowing Experience of Black and Hispanic-Owned Small Firms: Evidence from the 1998 Survey of Small Business Finances. *The Academy of Entrepreneurship Journal* 8, 1-20.

Coleman, S. 2003. Borrowing Patterns for Small Firms: A Comparison by Race and Ethnicity. The *Journal of Entrepreneurial Finance & Business Ventures* 7, 87-108

Coleman, S. 2004. Access to Debt Capital for Small Women- and Minority-Owned Firms: Does Educational Attainment Have an Impact? *Journal of Developmental Entrepreneurship* 9, 127-144.

Coleman, S., Robb, a. 2009. A Comparison of New Firm Financing by Gender: Evidence from the Kauffman Firm Survey Data. *Small Business Economics* 33, 397–411.

Consumer Finance Protection Bureau. 2012b. Analysis of Differences between Consumer- and Creditor-Purchased Credit Scores. Consumer Financial Protection Bureau Report (September).

Consumer Finance Protection Bureau. 2012a. Key Dimensions and Processes in the U.S. Credit Reporting System. CFPB White Paper (December).

DesRoches, D., Barton, T., Ballou, J., Potter, F., Zhao, Z., Santos, B., Sebastian, J. 2007. Kauffman Firm Survey (KFS) Baseline Methodology Report. October 24, 2007. Mathematica Policy Research.

DesRoches, D., Potter, F, Santos, B, Sengmavong, A. Zheng, Y. 2012. Kauffman Firm Survey (KFS) Sixth Follow-up Methodology Report. Mathematica Policy Research.

DeYoung, R., S. Frame, D. Glennon, P. Nigro. 2010. The Information Revolution and Small Business Lending: The Missing Evidence. FRB-Atlanta Working Paper 2010-7.

DeYoung, R., D. Glennon, P. Nigro. 2008. Borrower–Lender Distance, Credit Scoring, and Loan Performance: Evidence from Informational-Opaque Small Business Borrowers. *Journal of Financial Intermediation* 17, 113-143.

Edelstein, Robert H. 1975. Improving the Selection of Credit Risks: An Analysis of a Commercial Bank Minority Lending Program. *The Journal of Finance* 30, 37-55.

Elliehausen, G., Wolken, J. 1990. Banking Markets and the use of Financial Services by Small and Medium-Sized Businesses. *Federal Reserve Bulletin* 76 (Oct.), 801-817.

Elyasiani, E., Goldberg, L. 2004. Relationship Lending: A Survey of the Literature. *Journal of Economics and Business* 56, 315-330.

Fairlie, R.1999. The Absence of the African-American Owned Business: An Analysis of the Dynamics of Self-Employment. *Journal of Labor Economics* 17, 80-108.

Fairlie, R. 2006. Entrepreneurship among Disadvantaged Groups: An Analysis of the Dynamics of Self-Employment by Gender, Race and Education, in *The Life Cycle of Entrepreneurial Ventures, International Handbook Series on Entrepreneurship*, Vol. 3, ed. Simon Parker. Springer: New York.

Fairlie, R., Robb, A. 2009. Gender Differences in Business Performance: Evidence from the Characteristics of Business Owners Survey. *Small Business Economics* 33: 375–95.

Fairlie, R., Robb, A. 2007. Why are Black-Owned Businesses Less Successful than White-Owned Businesses? The Role of Families, Inheritances, and Business Human Capital. *Journal of Labor Economics* 25, 289-323.

Farber, H. 1987. The Recent Decline in Unionism in the United States. *Science* 238, 915-20.

Frame, W. S., Padhi, M., Woosley, L. 2004. The Effect of Credit Scoring on Small Business Lending in Low- and Moderate-Income Areas. *Financial Review* 39, 35-54.

Frame, W. S., Srinivasan, A., Woosley, L. 2001. The Effect of Credit Scoring on Small Business Lending. *Journal of Money, Credit, and Banking* 33, 813-825.

Greene, W. 2003. *Econometric Analysis*, 5th Ed. Upper Saddle River, Prentice Hall.

Hout, M, Rosen, H. 2000. Self Employment, Family, Background and Race. *Journal of Human Resources* 35 (4), 670-692.

Mach, T., Wolken, J. 2006. Financial Services Used by Small Businesses: Evidence from the 2003 Survey of Small Business Finance. *Federal Reserve Bulletin* 92 (Oct.), 167-195.

Maddala, G.S., 1983. *Limited Dependent and Qualitative Variables in Econometrics*, Cambridge University Press, Cambridge.

Mitchell, K. and D.K. Pearce. 2005. *Availability of Financing to Small Firms using the Survey of Small Business Finances*. U. S. Small Business Administration Office of Advocacy, Research Summary No. 257.

Petersen, M., Rajan, R. 1994. The Benefits of Lending Relationships: Evidence from Small Business Data. *The Journal of Finance* 46, 3-37.

Petersen, M., Rajan, R. 1997. Trade Credit: Theories and Evidence. *Review of Financial Studies* 10, 661-691.

Petersen, M. Rajan, R. 2002. Does Distance Matter? The Information Revolution in Small Business Lending. *The Journal of Finance* 57, 2533-2570.

Robb, A. 2013. *Access to Capital Among Young Firms, Minority-owned Firms, Women-owned Firms, and High-Tech Firms*. U.S. Small Business Administration Office of Advocacy, Research Summary No. 403.

Robb, A., Fairlie, R., Robinson, D. 2009. Financial Capital Injections among New Black and White Business Ventures: Evidence from the Kauffman Firm Survey. Working paper.

Robb, A., Wolken, J. 2002. Firm, Owner, and Financing Characteristics: Differences between Female- and Male-Owned Small Businesses. *Federal Reserve Discussion Series* Working Paper No. 2002-18.

U.S. Bureau of the Census. 1997. *1992 Economic Census: Characteristics of Business Owners*. Washington, DC: U.S. Government Printing Office.

APPENDIX 1: Additional Literature Review

Appendix 1.A. Additional Literature on Credit Scoring

Frame *et al*. (2001) find that banks using small business credit scoring (SBCS) increased their loan portfolio's allocation to small-business loans of less than $100,000. They conclude that SBCS allows these banks to make small-business loans that were "previously relationship-oriented or cost prohibitive." This conclusion raises one of the key issues addressed by this study: Has SBCS reduced the importance of firm-lender relationship?

Akhavein *et al*. (2005) use a hazard model to relate the adoption of SBCS to a number of "market, firm and managerial factors" in order to find out what drives technological innovation at large banks. This study finds that more centralized banking organizations were quicker to adopt SBCS.

Frame *et al*. (2004) match data from the FRB-Atlanta SBCS survey to U.S. Census tract data on income. They find that use of SBCS increased small business lending (in amounts under $100,000) in low- and moderate-income census tracts by about the same as in high-income census tracts.

Berger *et al.* (2005a) extend the analysis of Frame *et al*. (2001) by examining larger small-business loans ($100,000 - $250,000), as well as less than $100,000. Their study analyzes "how the adoption of SBCS affects the availability, price and risk of small business credit." It finds that SBCS results in greater quantities of small-business loans of less than $100,000 at higher prices and greater risk.

DeYoung *et al*. (2008) examine default rates on a sample of SBA-guaranteed loans issued during 1984-2001, a period during which the use of SBCS increased dramatically. The authors find that small-business loans originated by banks using SBCS are riskier (as measured by ex

post default rates) than those originated by banks not using SBCS. From this evidence, the authors conclude that SBCS results in "production efficiencies (that) encourage credit scoring lenders to expand output by making riskier loans at the margin."

DeYoung *et al*. (2010) use data on loans from the U.S. Small Business Administration's 7A program originated during 1984-2001 to provide evidence on how information technology drove the increase in borrower-lender distance during the 1990s. They find that this distance increased slowly and steadily prior to 1993, "but accelerated rapidly after that." They are able to assign the majority of this acceleration to the adoption of credit scoring by the bank lenders.

Appendix 1.B. Additional Literature on Relationship Lending

Berger and Udell (1998) summarize the findings of articles that appeared in a special issue of the *Journal of Banking & Finance* devoted to small business finance. They also develop a growth-cycle paradigm explaining how different capital structures are optimal for small firms at different points in the growth cycle.

Chakraborty and Hu (2006) use data from the 1993 SSBF to analyze how relationships affect a lender's decision to secure lines of credit and other types of loans. They find that the length of relationship decreases the likelihood of collateral for a line of credit but not for other types of loans. Previously, Berger and Udell (1995) had shown that longer relationships reduced the likelihood of collateral being required for lines of credit, using data from the 1987 SSBF.

Chakravarty and Yilmazer (2009) use data from the 1998 and 2003 SSBFs to develop a multistage model of the loan granting process that analyzes discouraged firms as well as firms that applied for credit. They find that relationships influence the decision to apply for a loan as well as the outcome of the loan application.

Han, Fraser, and Storey (2009) use data from the 1998 SSBF to provide evidence on discouraged borrowers. They find that firms in need of credit are less likely to be discouraged when they have longer relationships with their prospective lenders and when they have multiple banking relationships.

Berger, Cerqueiro and Penas (2011) use pooled data from the 1993, 1998 and 2003 SSBFs to analyze how differences in the level of debtor protection (in the form of state-level bankruptcy exemptions) affect the availability of credit. Results from this study show that firms reporting longer relationships with their prospective lender are less likely to be credit constrained.

Cole (2012) uses data from the 1993, 1998, and 2003 SSBFs to examine how the availability of credit differs between young firms (those in business ten years or less) and old firms (those in business more than ten years). Not surprisingly, the results from this study show that younger firms have much shorter relationships with their primary financial institutions. Results also show that younger firms are located much farther away from their primary financial institutions and have relationships with significantly fewer financial institutions. Each of these variables has been shown by previous researchers to be important in the credit allocation process.

Cole (2013) analyzes data from the 1987, 1993, 1998, and 2003 SSBFs to establish a set of stylized facts about the capital structure of small businesses. With respect to relationship lending, results from this study show that firms with multiple banking relationships are able to use more leverage than are firms with only one or no banking relationships.

Appendix 1.C. Additional Literature on Disparate Credit-Market Outcomes

Blanchflower *et al*. (2004) also use data from the 1993 SSBF and also find significant differences by race. Also using data from the 1993 SSBF, Coleman (2003) finds that black-owned small businesses are less likely to even apply for a loan because they expected to be turned down, i.e., that they were more likely to be a discouraged borrower as well as more likely to be a denied borrower.

Fairlie and Robb (2007) analyze confidential data from the Characteristics of Business Owners Survey conducted by the U.S. Census for evidence regarding why black-owned businesses are smaller, less profitable and less likely to survive than white-owned firms. They find that the lack of prior work experience negatively affects outcomes of black-owned firms.

Blanchard, Zhao, and Yinger (2008) examine data from the 1998 SSBF for evidence of discrimination against minority-owned firms. They find that both black-owned and Hispanic-owned firms are significantly more likely to be denied credit, which they interpret as strong, but not conclusive, evidence of discrimination by lenders against minorities.

Cole (2010) analyzes data from three iterations of the SSBF (1993, 1998, and 2003) for evidence on what types of firm use trade credit, bank credit, both, or no credit. This study find that one in five firms use no credit whatsoever, financing assets with 100 percent equity. In addition, it finds no evidence that female-owned or minority-owned firms are less likely to use bank credit than are non-Hispanic white-owned firms.

APPENDIX 2. Methodology

Need Credit =

   a + B' Credit Score + C ' Minority + D' Credit Score × Minority

   G ' Relationship + H ' Firm + I ' Owner + e   (1)

where:

   Need Credit equals one for firms reporting that they had a need for credit and equals zero

   for firms reporting no need for credit.

   Credit Score is equal to the categorical representation of the firm's D&B credit score, or

   a set of dummy variables for each categorical representation of the firm's D&B

   credit score as described above, with the best category being omitted. In the

   SSBF, this variable ranges from 1 to 6, where higher values correspond to better

   credit scores, while in the KFS, this variable ranges from 1 to 5 with higher values

   corresponding to worse scores (See Figures 1 and 2).

   Minority is a vector of dummy variables indicating the race, ethnicity, and gender of the

   firm's primary owner.

   Credit Score × Minority is a vector of interaction terms equal to the product of *Credit*

   Score and the *Minority* ownership dummy variables.

   Relationship is a vector of firm-lender relationship variables.

   Firm is a vector of firm characteristics expected to influence the need for credit.

   Owner is a vector of owner characteristics expected to influence the need for credit.

   B, C, D, G, H and *I* are vectors of parameter estimates;

   a is an intercept term; and

   e is a random error term.

Discouraged =

$a + B$' *Credit Score* + C ' *Minority* + D' *Credit Score* × *Minority*

G ' *Relationship* + H ' *Firm* + I ' *Owner* + e (2)

where:

Discouraged equals zero for firms reporting that they had applied for credit and equals

one for firms reporting that they were discouraged from applying, conditional

upon reporting a need for credit.

Credit Score is equal to the categorical representation of the firm's D&B credit score as

described above, or set of dummy variables for each categorical representation of

the firm's D&B credit score as described above, with the best category omitted.

Minority is a vector of dummy variables indicating the race, ethnicity and gender of the

firm's primary owner.

Credit Score × *Minority* is a vector of interaction terms equal to the product of *Credit*

Score and the minority ownership dummy variables.

Relationship is a vector of firm-lender relationship variables.

Firm is a vector of firm characteristics expected to influence the decision to apply for

credit.

Owner is a vector of owner characteristics expected to influence the decision to apply for

credit.

B, C, D, G, H and *I* are vectors of parameter estimates;

a is an intercept term; and

e is a random error term.

Denied =

a + *B' Credit Score* + *C' Minority* + *D' Credit Score* × *Minority*

G' Relationship + *H' Firm* + *I' Owner* + e (3)

where:

Denied equals zero for firms reporting that they applied for credit and were extended

credit and equals one for firms reporting that they applied for credit and were

denied credit.

Credit Score is the categorical representation of the firm's D&B credit score as described

above, or a set of dummy variables for each categorical representation of the

firm's D&B credit score as described above, with the best category being omitted.

Minority is a vector of dummy variables indicating the race, ethnicity and gender of the

firm's primary owner;

Credit Score × *Minority* is a vector of interaction terms equal to the product of *Credit*

Score and the *Minority* ownership dummy variables;

Relationship is a vector of firm-lender relationship variables;

Firm is a vector of firm characteristics expected to influence lender's decision to grant

credit;

Owner is a vector of owner characteristics expected to influence the lender's decision to

grant credit;

B, C, D, G, H and *I* are vectors of parameter estimates;

a is an intercept term; and

e is a random error term.

This three-stage model is estimated sequentially, using specialized survey procedures of the STATA statistical software package that account for the different sampling strata and sampling weights. This is critically important for making inferences about the target population of small businesses because both the SSBF and KFS are stratified random samples with complex survey designs. If the sampling weights were not used, then the results would be representative only of the sample, not of the target population. For explanatory variables, the analysis generally follows the existing literature on the availability of credit to small businesses. (See, e.g., Cole 1998; Cole, Goldberg and White 2004; Cole 2009; and Robb 2013).

APPENDIX 3. Control Variables

To control for observable differences in minority-owned and nonminority-owned firms, the study includes three vectors of control variables: firm characteristics, owner characteristics and firm-lender relationship characteristics. (Relationship characteristics are available only for the SSBF, not for the KFS).

The analysis includes a vector of **firm characteristics** that includes public reputation as proxied by *Firm Age*, *Firm Size* as measured by annual sales revenues, firm profitability as measured by return on assets (*ROA*), *Firm Leverage* as measured by the ratio of total debt to total assets, *Firm Liquidity* as measured by the ratio of cash and due to total assets; and dummy variables for organizational form (corporations versus *Proprietorships*) and firm industry (based upon two-digit Standard Industrial Code (SIC). Logarithmic transformations are applied to *Firm Age* and *Firm Size* in order to incorporate nonlinear relationships and mitigate the influence of outliers.

For the KFS, all firms are of the same age so that variable is omitted. Firm size, firm leverage and firm liquidity are proxied by categorical range variables for annual firm sales, total firm debt and firm cash on hand. Firm profitability is proxied by an indicator variable identifying firms that reported losing money (*Loss*).

A vector of **owner characteristics** includes the minority status and gender as measured by dummy variables for minority-owned and for female-owned firms; owner's reputation as measured by *Owner's Age*, *Owner's Experience*, the *Personal Wealth* of the owner, an indicator for owners who have declared *Personal Bankruptcy* during the previous seven years and for owners who are *Personally Delinquent* on personal credit obligations, and two indicator variables for educational attainment (*College Degree* or *Graduate Degree*). Logarithmic

transformations are applied to owner's age, years of experience and personal wealth. (*Personal Wealth* , *Bankruptcy* , and *Personal Delinquency* are not available from the KFS.) The bankruptcy and delinquency variables are included as proxies for the owner's personal credit score, which is not available from the SSBF. Anecdotal evidence suggests that bankers often use the personal credit score of a firm's owner in evaluating the firm's credit application, either by itself or in conjunction with the business's credit score.

For the SSBF, a set of variables is included that measure the strength of the firm's **relationships** with its primary source of financial services/prospective lender, including the *Length of Relationship* (see Petersen and Rajan, 1994); the *Distance* between the firm and its primary source of financial services/prospective lender (see Petersen and Rajan, 2002); and the *Number of Banks* with which the firm has relationships (see Bulow and Shoven, 1978). A logarithmic transformation for *Length of Relationship* and *Distance* is used in order to incorporate a nonlinear relationship and mitigate the influence of outliers. For these variables, a one-unit change (in years or miles) is more important at lower levels than at higher levels. (Relationship variables are not available from the KFS.)

APPENDIX 4: Detailed Discussion of Fitting the Models

In this appendix is a detailed discussion of the outcomes from fitting the six different

specifications of each of the three models for both the SSBF and KFS. This is designed to

provide more insights into what control variables reduce and/or eliminate the explanatory power

of the categorical credit score in explaining the three credit-market outcomes.

Appendix 4.1: Fitting the SSBF Need-Credit Model

In the first specification, only *Credit Score 1* and *Credit Score 2* are statistically

significant at the 0.10 level; both are greater than one and significant at the 0.05 level, indicating

that firms with worse credit scores are significantly more likely to need credit. *Credit Score 2*

firms are 46 percent more likely, and *Credit Score 1* firms are approximately one and a half

times more likely to need credit than are *Credit Score 6* firms.

Results indicate that the data show no evidence of a disparate impact of the credit score

on the decision to seek credit by either female-owned or minority-owned firms, i.e., the credit

score for female-owned firms has the same impact on the need for credit as does the credit score

for male-owned firms, and the credit score for minority-owned firms has the same impact on the

need for credit as does the credit score for white-owned firms.

In the second specification, four variables are added to control for the firm's financial

condition: log of sales (a measure of firm size), return on assets (ROA, which is a measure of

firm profitability), leverage (total liabilities divided by total assets), and liquidity (cash divided

by total assets). Each of these four control variables has the expected sign and is highly

significant at better than the 0.001 level. Larger and more highly levered firms are more likely to

need credit, whereas more profitable firms and more liquid firms are less likely to need credit,

consistent with the pecking-order theory of capital structure. Inclusion of these firm financials

increases the statistical significance of *Credit Score 3* to more than the 0.05 level, but the results

regarding the impact of the credit score on need for credit by female-owned and minority-owned

firms are unchanged.

In the third specification, a set of eight dummy variables are added for firm industry and

three variables are added to control for key firm nonfinancial characteristics, i.e., log of *Firm*

Age, an indicator for *Proprietorships* and an indicator for *Urban* location. Older firms and urban

firms are significantly less likely to need credit. The results regarding the credit score are

qualitatively unchanged.

In the fourth specification, seven variables are added to control for differences in owner

characteristics: log of *Age*, log of *Experience*, indicators for *Graduate* and *College* degrees, the

log of personal wealth and indicators for owners that have filed for *Bankruptcy* or reported that

they were *Delinquent* on personal obligations within the previous three years. All but *Experience*

are statistically significant at the 0.10 level or better. A firm with an older, more highly educated,

or wealthier owner is less likely to need credit, whereas a firm whose owner has declared

Bankruptcy or reported *Personal Delinquency* is more likely to need credit. Inclusion of the

owner characteristics and personal credit score proxies renders *Credit Score 2* and *Credit Score 3*

insignificant, but does not change the results regarding the impact of the credit score on female-

owned and minority-owned firms.

Fifth, three variables are added to control for firm-lender relationships: the *Distance*

between the firm and its primary financial institution, the *Length* of the firm's relationship with

its primary financial institution, and the *Number of Banks* with which the firm has relationships.

Each has been shown by previous researchers to be important in the credit allocation process,

and each is highly significant in this model. Firms with longer relationships are less likely to

need credit, whereas firms more distant from their primary financial institution and firms with more banking relationships are more likely to need credit. Inclusion of the three firm-lender relationship variables renders *Credit Score 1* statistically insignificant, but does not change the insignificant results regarding the impact of the credit score on female-owned and minority-owned firms.

Finally, the analysis tests whether credit scores reduce the importance of relationship variables by excluding them from the fifth specification. As shown in the sixth specification, the results for the three relationship variables are virtually unchanged, indicating that the credit score does not appear to reduce the importance of lending relationships.

Appendix 4.2: Fitting the SSBF Discouragement Model

In the first specification, *Credit Scores 1 – 4* all are statistically significant at better than the 0.01 level, indicating that firms with all but the best credit scores are more likely to be discouraged from applying for credit. The odds ratios indicate that *Credit Score 4* and *Credit Score 3* firms are almost three times as likely to be discouraged as *Credit Score 6* firms, while *Credit Score 2* and *Credit Score 1* firms are almost four times as likely to be discouraged as *Credit Score 6* firms. While the odds ratio for *Credit Score 5* firms is greater than 1.00, it is not statistically significant. *Female* also has an odds ratio that is significantly greater than one, indicating that female-owned firms are more than two and a half times more likely to be discouraged than are male-owned firms. The t-statistics for the indicator for minority-owned firms and the interactions of credit score with female-owned and minority-owned indicate that these variables are not statistically significant, or, equivalently, that the odds ratios are not significantly different from even.

Second, four control variables are added for the firm's financial condition. Only log of sales is significant; its odds ratio is less than 1.00, indicating that larger firms are significantly less likely to be discouraged. Inclusion of the firm financials reduces the significance of the credit score dummies and the indicator for female-owned firms, but also renders the interaction of the credit score with minority-owned firms statistically significant. The odds ratio is greater than one, indicating that minority-owned firms with higher credit scores are more likely to be discouraged than are white-owned firms.

Third, the eight industry dummies and three control variables for key firm nonfinancial characteristics are added. All three control variables are highly significant. Older firms are less likely, whereas proprietorships and firms in urban areas are more likely, to be discouraged. Inclusion of the firm characteristics reduces the significance of the credit score dummies and renders the credit score interaction with minority ownership insignificant.

Fourth, the seven control variables for owner characteristics are added. *Personal Wealth* and the indicators for *Personal Delinquency* and *Personal Bankruptcy* are statistically significant. Firms whose owners are wealthier are less likely to be discouraged, whereas owners with worse personal credit histories are more likely to be discouraged. Inclusion of owner controls renders all of the credit score dummies statistically insignificant, but also turns the indicator for minority-owned firms and the interaction of credit score and minority-owned significant. *Minority-Owned* has an odds ratio of less than one, indicating that minority-owned firms are less likely to be discouraged, but the interaction with credit score has an odds ratio greater than one, indicating that minority-owned firms with better credit ratings are more likely to be discouraged than are white-owned firms with better credit ratings.

Fifth, the three control variables for firm-lender relationships are added. Both *Length of Relationship* and *Number of Banks* have odds ratios less than 1.00 and significant t-statistics, indicating that firms with longer relationships and more banking relationships are less likely to be discouraged. The results regarding the credit score variables remain unchanged from specification four.

Finally, the analysis tests whether credit scores reduce the importance of relationship variables by excluding them from the model. As shown in the sixth specification, the results for the three relationship variables are virtually unchanged, indicating that the credit score does not appear to reduce the importance of lending relationships to the availability of credit.

Appendix 4.3: Fitting the SSBF Denied-Credit Model

In the first specification, *Credit Score 2* and *Credit Score 1* are both statistically significant at the 0.05 level. Their odds ratios indicate that *Credit Score 2* firms are almost three and a half times more likely, and *Credit Score 1* firms are more than five times more likely, to be denied credit than are *Credit Score 6* firms. *Minority-owned* also is highly significant with an odds ratio indicating that such firms are eleven times more likely to be denied credit than are white-owned firms.

The indicator for female-owned firms and the credit score interactions are not significant in this specification. Hence, there is no evidence from this specification of a disparate impact of the credit score on either female-owned or minority-owned firms. In other words, bankers do not apply more weight to credit scores when evaluating minority-owned firms relative to white owned firms. Banks do not appear to weigh credit scores differently across race or gender.

Second, the four variables to control for the firm's financial condition are added. Both log of *Sales* and *Leverage* are significant; the odds ratio for sales is less than 1.00 whereas the odds

ratio for leverage is greater than 1.00, indicating that smaller firms and more levered firms are more likely to be denied credit when they apply. The results regarding the credit score are unchanged by inclusion of the firm financials.

Third, the industry dummies and three control variables for key firm nonfinancial characteristics are added. Only one of the industry dummies and none of the three nonfinancial firm controls are statistically significant, so it is not surprising that the results regarding the credit score remain unchanged.

Fourth are the seven control variables for owner characteristics. Only *Graduate Education*, *Personal Delinquency* and *Personal Bankruptcy* are statistically significant, but each of these is significant at better than the 0.001 level. Firms whose owners are more educated are less likely, whereas owners with worse personal credit histories are more likely, to be denied credit. Inclusion of owner controls reduces, but does not eliminate the significance of the credit score dummies; *Credit Score 1* remains significant at the 0.05 level. Both of the credit score interactions remain statistically insignificant, indicating that the data provide no evidence of a disparate impact on female-owned or minority-owned firms..

Fifth are three variables to control for firm-lender relationships: Only the *Number of Banks* is significant. Its odds ratio is greater than 1.00, indicating that firms with more relationships are more likely to be denied credit, which is consistent with the theory of monopoly rents put forth by Petersen and Rajan (1994). The results regarding the credit score remain unchanged from specification four.

Finally, the analysis tests whether credit scores reduce the importance of relationship variables by excluding them from the model. As shown in the sixth specification, the results for

the three relationship variables again are virtually unchanged, indicating that the credit score does not appear to reduce the importance of lending relationships.[19]

Appendix 4.4: Fitting the KFS Need-Credit Model

In the first specification, only *Credit Score 2* and *Credit Score 3* are statistically significant at the 0.01 level, and their odds ratios indicate that they are about 50 percent less likely to need credit than *Credit Score 1* firms. The odds ratios for *Credit Score 4* and *Credit Score 5* are not statistically different from even. This strange result may at least in part be attributable to the distribution of credit scores in the KFS, where more than 70 percent of the firms are in the 2 or 3 categories. None of the other variables are significant at even the 0.10 level.

In the second specification, four variables are added to control for firm financial condition. Three are highly significant. Larger firms, more highly levered firms, and unprofitable firms are much more likely to need credit. Inclusion of these controls results in statistical significance for the odds ratio of *Credit Score 5*, indicating that a firm with the worst categorical credit score is almost twice as likely to need credit as a firm with the best categorical credit score. These results are quite similar to what was found in the second specification of the need credit model based upon the SSBF data, although the odds ratio on the credit score dummy is lower.

In the third specification, a set of 14 industry dummies and a control for organizational form are added. The indicator for *Proprietorship* is not significant and only one of the industry

---

[19] To investigate whether bankers might be discriminating against minorities or women through relationship lending,, e.g., providing more credit to firms with which they have relationships but only if they are non-Hispanic white-owned, the indicators for minority-owned and female-owned firms were interacted with each of the three relationship variables. None of these six interaction terms were found to be statistically significant.

dummies is significant; their inclusion does not qualitatively change the credit score results from the previous model.

In the fourth specification, four control variables for owner characteristics are added to the model. Owner age and an indicator for a graduate degree are significant at the 0.10 level. A firm whose owner has a graduate degree is more likely to need credit, while a firm whose owner is older is less likely to need credit.

Appendix 4.5: Fitting the KFS Discouragement Model

In the first specification, the odds ratio of each of the four dummies for the worst categorical credit-score categories is statistically significant at the 0.05 level. The odds ratios indicate that these firms are two to six times more likely to be discouraged than are firms with the best categorical credit score. None of the remaining four variables are even marginally significant.

Next, the four control variables for firm financial condition are added to the model. Odds ratios for three of the four are significant at better than the 0.01 level, while the fourth is significant at the 0.10 level. Larger, more levered, and more liquid firms are less likely to be discouraged, while unprofitable firms are more likely to be discouraged. Inclusion of the controls for firm financials reduces, but does not eliminate, the importance of the credit score dummies.

In the third specification, industry dummies and the control for organizational form are added to the model. The odds ratio for *Proprietorship* is highly significant and indicates that proprietorships are more than three times as likely to be discouraged as are firms organized as corporations. Only one of the industry dummies is significant at even the 0.10 level.

In the fourth specification, the four control variables for owner characteristics are added. None of the four variables are significant and their inclusion does not affect the results for the *Credit Score* variables as shown in specification three.

Appendix 4.6: Fitting the KFS Denied-Credit Model

In the first specification, only *Credit Score 5* is statistically significant at even the 0.10 level, and its odds ratios indicates that KFS firms with the worst categorical credit score are about three as likely to be denied credit as are *Credit Score 1* firms. The odds ratio for Credit Score 4 indicates that firms in this bucket are about twice as likely to be denied credit, but the coefficient lacks statistical significance. The two minority ownership variables are not significant by themselves, but are jointly significant. When the credit-score/minority-ownership interaction is dropped from this specification, the *Minority* has an odds ratio of 3.6 with a t-statistic of 4.4, indicating that minority-owned firms are denied credit at about three and a half times the rate for non-Hispanic white-owned firms.

In the second specification, the four control variables for firm financial condition are added to the model. Only the coefficient on *Sales* is statistically significant at even the 0.10 level. Inclusion of the financial variables renders Credit Score 5 statistically insignificant.

In the third specification, industry dummies and the control for organizational form are added to the model. Nine of the industry dummies are statistically significant at the 0.10 level, two (Retail and Mining) at the 0.05 level, and one (Retail) at the 0.01 level. Inclusion of the industry dummies renders *Sales* insignificant, but *Liquidity* significant.

In the fourth specification, the four control variables for owner characteristics are added. Owner age is significant at the 0.10 level and inclusion of the ownership variables renders leverage significant at the 0.10 level, along with liquidity.