The Demand and Supply for Post-Katrina Disaster Aid: A Triple-Hurdle Model of SBA Disaster Loans for Small Businesses in Mississippi

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ABSTRACT

Following Hurricane Katrina, the United States government provided $45 billion in loans and rebuilding funds to individuals and businesses for the purpose of repairing the damage caused by the hurricane. However, it is not yet clear what impact this assistance had on small businesses in affected areas. In particular, the role of Small Business Administration (SBA) loans has yet to be fully examined. Though few doubt the benefits of short-term and immediate disaster relief, there is some debate on the benefits of SBA loans. Evidence suggests that receiving business loans may do more harm than good, if the loan ultimately increases debt load. In this study we contribute to the disaster relief literature through completing the first analysis regarding the receipt of SBA loans after Hurricane Katrina. We find that there are several characteristics which increase the probability of application for a loan, but a set of different characteristics which determine the amount ultimately received. Further, results indicate that targeting programs for certain groups such as women or minorities were unsuccessful in directing loans to these groups.

1. INTRODUCTION

When Hurricane Katrina hit the south-eastern United States in August of 2005, it became the costliest hurricane in the history of the country, with more than $108 billion in damages and over 1,800 lives lost (FEMA, 2013). The recovery effort was similarly unprecedented: over 13 million Americans donated money as individuals, the Red Cross provided $2 billion in emergency aid, and, in addition to $75 billion in immediate relief, the United States government promised $45 billion in loans and rebuilding funds (FEMA, 2013). However, despite the tremendous damage incurred in many areas, it is not clear what demand existed for reconstruction assistance. In particular, the demand for and supply of Small Business Administration (SBA) loans has yet to be fully examined. Though few doubt the benefits of short-term and immediate disaster relief, there is some debate on the benefits of SBA loans, and hence, related debate on their supply and demand.

SBA disaster relief assistance is intended to support families and businesses through the recovery of losses that are not otherwise insured. In this study we investigate the factors which influence application for as well as acceptance and receipt of SBA loans after Hurricane Katrina using a triple-hurdle model. Results indicate that there are several characteristics that increase application for a loan, but a set of different characteristics that determine the approval of a loan, as well as the amount ultimately received. With this analysis, we are able to better determine the role of federal government loan assistance in small business disaster recovery, as well as suggest future strategies for aid distribution to small businesses.

This article is structured as follows. Section two includes background on the SBA and its loan program, as well as a brief literature review on loan receipt after disasters. Sections three

and four discuss the methodology implemented and data used, respectively. Finally, sections five and six include results and a conclusion.

2. BACKGROUND AND LITERATURE REVIEW

The Small Business Act of 1953 created the Small Business Administration (SBA), with the stated function to: "aid, counsel, assist and protect, insofar as is possible, the interests of small business concerns." SBA now provides a number of financial assistance programs for small businesses which are designed to help firms meet financing needs. Most commonly this is done through loans. Generally, however, SBA does not make loans directly to small businesses. Instead, it sets guidelines for loans, which are then made by its partners (including "lenders, community development organizations, and microlending institutions" (US Small Business Administration, 2013)). Therefore, when a business applies for an SBA loan, it is actually applying for a commercial loan; albeit one that is structured per SBA requirements, with an SBA guarantee.

Disaster loans are structured somewhat differently, as they are provided directly from the government. During disasters, regions are designated as "declared disaster areas". These regions are then potentially eligible for financial assistance from the SBA. Businesses of any size, most private nonprofit organizations, and homeowners may apply to the SBA for a loan after a disaster. Loans are intended to cover losses not fully protected by insurance. Three primary loan types exist including: 1) home and personal property loans; 2) business physical disaster loans; and 3) economic injury disaster loans. The interest rate for such loans is stipulated to not exceed 4 percent, if it is not possible for the borrower to acquire credit elsewhere. For businesses that are

able to obtain credit elsewhere, the interest rate is stipulated to not exceed 8 percent. Whether credit is available elsewhere is ultimately determined by the SBA.

While all business owners in "declared disaster areas" are eligible for SBA loans, preferential terms were designated for certain groups, including female, minority, and veteran business owners, following Hurricane Katrina. It is not clear, however, if these groups ultimately received loans. Additionally, coastal businesses were also eligible for a special class of loan, but this impact on application and receipt is also unclear.

Although SBA loans were available following Hurricane Katrina, evidence suggests that the process was largely mismanaged and that many eligible applicants were rejected. The Associated Press released a report of SBA data, finding that 55 percent of homeowners and businesses that applied for help were turned away. Of 318,953 applications processed, 175,463 were rejected and 143,490 were approved. Further, of the approved loan money, only 60 percent ultimately reached recipients.[1] SBA officials claim many applicants never accepted the loans as they found other ways to rebuild. However, many applicants indicated that applications were abandoned as the process took too long and was overly complicated (Weiss, 2010).

Previous literature also suggests that the loan application processes following disasters is problematic. Nigg and Tierney (1990) examine granted loans after the Whitter-Narrows earthquake of 1987, finding mixed results on characteristics which lead to loan receipt. Tierney (1995) further finds that, even when available, as after the 1993 Midwest Floods and the 1994 Northridge Earthquake, very few eligible parties actually apply for loans. The United States Government Accountability Office has undertaken review the SBA loan procedures, leading to

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[1] While this problem is not observed in our sample, it still speaks to the issues which exist with the SBA loan process and may influence application and receipt for loans.

extensive testimony regarding attempts to modify and improve the loan process, due to shortcomings following Hurricane Katrina (USGAO, 2010).

Another body of literature has examined the effect of disaster loans on small businesses. Haynes et al. (2011) find that aid does not play a role in the survival of a firm. Alesch et al. (2001) find similar results, indicating that if a firm's debt load is increased by receipt of a loan, they are ultimately worse-off.

This study contributes to the literature through determining which characteristics of small businesses and their owners are associated with applying for a SBA loan and, ultimately, the receipt of that disaster loan. We also attempt to investigate the effect of targeting programs, through determining if certain characteristics of businesses and their owners are more likely to lead to loan receipt.

3. METHODOLOGY

In this section we discuss the methodology employed, including, the estimation and model employed in our analysis. We discuss these components in two sections: 1) estimation strategies; 2) literature; and 3) model specification. The former focuses on the development of the triple-hurdle and how the form appropriately suits our question, supported with past applications from the literature. The latter more specifically gives specification of the model, including variables used in each stage.

a. Estimation Strategies

Cameron & Trivedi (2009), as well as Wooldridge (2010), serve as important sources in this section. The estimation strategy is derived from these sources discussions' of multiple step models. Notation follows that of Cameron & Trivedi.

In our specification, a business owner must overcome multiple steps in order to ultimately receive a loan. The business owner must first apply, and then be approved by the SBA, before finally receiving a loan. This system therefore lends itself to a multiple hurdle structure, as crossing a hurdle results in participation. Please see Figure 1[2] for an illustration of the possible multiple hurdle models possible.
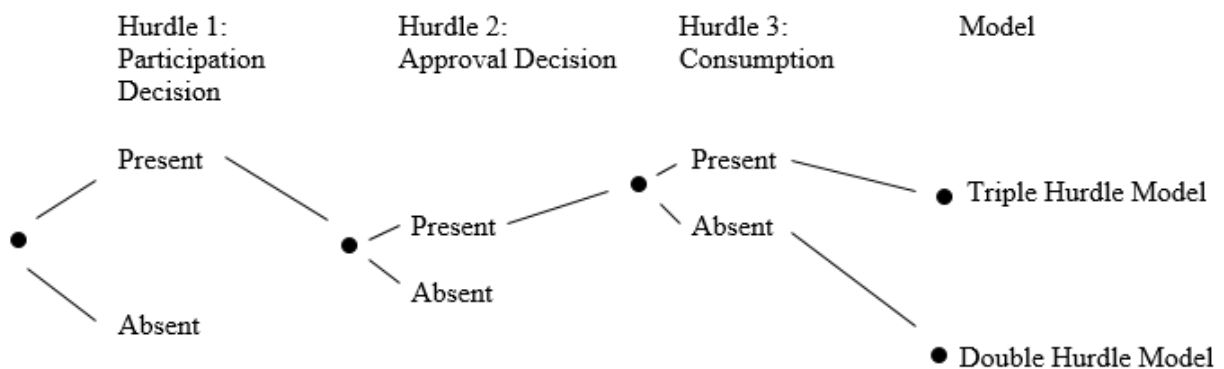
Figure 1: Hurdle Models

In this case, the first hurdle designates whether or not an individual applied for a loan, the second hurdle designates whether or not the individual was accepted for a loan, and the third and final hurdle designates how much money was received as a loan. To be included in the next stage, an individual must give a positive response to the question. From the diagram, we can conclude, the triple hurdle is the appropriate choice for our questions, as we have three "present" steps.

As these three questions signify multiple elements which contribute to a single process, we use a triple-hurdle model for the analysis. This model allows for the distinguishing of the determinants of the various decisions (that is, completing the application, and being approved for

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[2] This figure is inspired by a similar diagram in Carlevaro et al. (2012).

the loan) from those of the amount of participation (that is, the amount of the loan received). This model permits separate stochastic processes for the participation decisions, as well as the actual consumption decision. This problem was initially modeled by Cragg (1971) for the case of two hurdles. For the case at hand, as previously identified, three hurdles are required, and therefore slight modifications are made to the model.

The model is given by Equations (1) and (2):

$$f(y_1|x_1) = \begin{cases} \Pr[d_1 = 0|x_1] & if \ y_1 = 0 \\ \Pr[d_1 = 1|x_1] f(y_1|d_1 = 1, x_1) & if \ y_1 = 1 \end{cases} \quad (1)$$

Equation (1) signifies the hurdle from the first to the second stage, wherein an individual "hurdles" to the second stage, if he or she applied for an SBA loan. Therefore, if the left-hand side is equal to zero in the first stage, the individual does not make it to the second stage.

The second stage is similar, except that, this time, an individual "hurdles" to the third stage, if he or she was approved for a loan, and received a positive amount.

$$f(y_2|x_2) = \begin{cases} \Pr[d_2 = 0|x_2] & if \ y_2 = 0 \\ \Pr[d_2 = 1|x_2] f(y_2|d_2 = 1, x_2) & if \ y_2 > 0 \end{cases} \quad (2)$$

To ensure that participants exist in each stage, that is, that some subset of the sampled individuals make it over each hurdle, the density $f(y_i|d_i = 1, x_i)$ must be for a positive-valued random variable.

The hurdle model separates each estimation stage into a discrete choice model. These stages use all observations, as appropriate, truncated after each hurdle, and the estimator of the

parameters of the density $f(y_i| d_i = 1, \boldsymbol{x_i})$ use only observations that surpass each hurdle, with $y_i > 0$.

We also suspect that heteroskedasicity may be a problem. We suspect that there may be different covariance structures within the data[3]. Therefore, we relax the Gauss-Markov homoscedasticity assumption, allowing for the existence of different covariances across groups.

This is achieved using clustered standard errors, permitting flexibility in the variance-covariance matrix. We choose to cluster with two levels, considering if a business is coastal or not.

b. Literature

Though Cragg developed the double-hurdle model in 1971 to deal with expenditure models that include excess zeros, it has been applied in multiple other ways in recent decades, most frequently to a range of consumption problems. It has, of course, been extended to a triple-hurdle model, employed in this analysis, with a somewhat limited literature existing on that topic.

Double hurdle models are abundant in the literature, with some of the earliest work tying consumption and addiction. Jones researched cigarette consumption, and developed some of the first applied double-hurdle models. The work also extended hurdle models by allowing restrictions on the stochastic specifications of the models, permitting decomposition into multiple groups, such as never-smokers, former-smokers, and smokers. The literature on addiction has been extend (Jones, 1989; Jones, 1992; Labeaga, 1999), and also applied to many more general cases of consumption (Lin & Milon, 1993; Yen, 1993; Yen & Jones, 1997; Newman et al., 2003; Ricker-Gilbert et al., 2011).

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[3] We believe our covariance structures are locationally determined. For this reason, we first attempted to use clustered-standard errors. However, due to lack of observations in our third stage, we changed our method to White's robust standard errors.

Double hurdle models have also been applied in the case of loans (Danis &Pennington-Cross, 2005; Moffat, 2005). The probability of default of loans has been particularly emphasized. Many prior models of default assumed that the process which results in non-default is the same as that which results in default. The presumption that this is not the case led to the use of double-hurdle models, as the event that a borrower is a potential defaulter, and the extent of the default by that borrower are treated separately. Moffat (2005) discusses this difference, as well as the existence of "never-defaulters" with a Box-Cox model.

Simply due to the nature of many consumption problems, that is, making a decision to consume something, and then consuming it, double-hurdle models are somewhat more common in the literature than triple-hurdle models. Triple hurdles require multiple decisions, which are somewhat less standard when determining whether or not to consume. However, the triple hurdle model has been applied to a variety of problems, including market participation (Burke, 2009; Okello et al., 2012), the role of poverty in consumption (Sharpe & Abdel-Ghany, 1999), as well as loans to permit continuation of operation and assist with interest payment (Ahrendsen et al., 2011) and microcredit and microinsurance (Akter & Fatema, 2011). It is interesting to note that these categories are subsets of those mentioned earlier in the double-hurdle literature. Our study will extend the existing literature by providing a different application of the triple-hurdle model to loan demand, and extending the previous work on loans to include application and receipt.

c. *Model Specification*

In this section, the model specification is discussed, including the equations used in calculating each regression, and the variables chosen for each equation. Model functional form specifications are determined based on the standard hurdle models, with initial stages as probit regressions, and later stages as log-normal regressions.

The model takes three hurdles; therefore, we run three regressions, which can be specified with three equations. For these equations, we follow derivations by Duan et al., (1983), as suggested by Cameron and Trivedi (2009). A similar model was suggested by Wooldridge (2010).

In the first stage, we use a probit regression model to determine whether or not a business owner applied for a SBA loan. Therefore:

$$\Pr[d_1 = 0 | \boldsymbol{x_1}] = \Phi(x_1' \beta_1). \tag{3}$$

Equation (3) indicates a normally distributed probability function regression. As the second stage considers a similar regression, we again use a probit model to determine whether or not the business owner was approved for the loan. Only individuals who passed the first hurdle, by applying for a loan, are included in this step. Therefore:

$$\Pr[d_2 = 0 | \boldsymbol{x_2}] = \Phi(x_2' \beta_2). \tag{4}$$

Again, Equation (4) indicates a normally distributed probability function regression. The third equation changes slightly, as we now have a numerical amount of the loan received.[4] Following the literature, we use a log-normal least squares regression for received loans, given that the business was approved for a loan, passing the second stage. For the third stage, we find:

$$ln\ y_3 | d_3 = 1, x_2 \sim N[x_2' \beta_3, \sigma_3^2]. \tag{5}$$

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[4] For this, we use the log of the amount received in order to achieve a normal distribution. This will be discussed in more detail later.

We run Equations (4), (5), and (6) in order to estimate the relationship between loan application, loan approval, and loan amount, with a variety of business and individual characteristics, which we will discuss in the subsequent section.

Finally, we determine which variables are appropriate and necessary to include in each stage of the regressions. The variables included in each equation need to reflect the considerations which impact the respective decision at each stage. In the first stage, the decision to apply is made by the business owner; therefore, the variables included in the regression are characteristics of that owner. However, in the second and third stages, the decision for approval and the decision for the amount received are both decisions made by the SBA. Therefore, in these stages, the variables included in the regression are characteristics that would be important to the SBA for loan approval. The equations used are the same in each stage. This method is derived from a similar technique employed by Moffat (2005). Moffat concludes that decisions made by a third party will be different than those made by the business, and therefore, variables included will change across stages. For a full list of variables used in each stage, please see Table 1.

It is worth noting that several variables are included in all stages. These include 1) gender of business owner; 2) race of business owner; 3) whether the business owner is a veteran; 4) whether the business is located along the coast; 5) experience of business owner; and 6) whether the business had insurance. The first four characteristics are given specific and special considerations for SBA loans, and therefore may play a role in application, as well as receipt. Therefore, we want to know what relationship exists between these and the dependent variables

in each stage. Additionally, the latter two traits play a role determining if a business receives a

loan, and likely also have some role in determining if they apply at all.

Table 1. Variables used in Triple Hurdle Model

Variable	Description
First Hurdle: Did the business apply for a loan?	
gender	= 0 if male, = 1 if female
education	highest level of education attained, in years
race	= 0 if white, = 1 if non-white
veteran	= 0 if not, = 1 if yes
married	= 0 if not, = 1 if yes
ownership	year in which owner began working in the business
experience	number of years worked in industry
home	= 1 if business operating from personal residence, = 0 if not
insurance	= 1 if business had insurance, = 0 if not
past	= 1 if previously suffered disaster, = 0 if not
qual_damage	owner's qualitative perception of incurred damage
coast	= 1 if the business is coastal, = 0 if not
Second and Third Hurdle: Was the business approved for a loan? What amount of loan was received?	
employees	number of employees
insurance	= 1 if business had insurance, = 2 if not
claim[5]	= 1 if claim filed with insurance, = 2 if not
paid	= 1 if claim was paid, = 2 if not
log of quant_damage	log of damage to business, in dollars
revenue[6]	revenue tiers, entered categorically, representing dollar earnings
age	number of years business has existed
gender	= 0 if male, = 1 if female
race	= 0 if white, = 1 if non-white
veteran	= 0 if not, = 1 if yes
experience	number of years worked in industry
coast	= 1 if the business is coastal, = 0 if not

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[5] This term, as well as paid below, are included for both residential and businesses areas.
[6] This term is included as five revenue tiers, represented as dummy variables when a business falls into a particular tier. Further, the first tier is omitted for identification reasons. Please see page 11 for more detail on the tiers.

4. DATA

To conduct our analysis, we use the Small Business Disaster Recovery Study, collected by Drs. M. Marshall and H. Schrank. The dataset follows approximately 500 small businesses in the 10 southern-most counties of Mississippi. The dataset includes resilience data and business characteristics. Information on aid receipt is also included, with emphasis on disaster assistance, its perceived importance and source, and detailed data on the SBA loan process.

Eligible businesses were founded before August of 2005 and were operating during the period of Hurricane Katrina in the 10 county area of interest. Further, the respondent was determined to be eligible based on their ownership stake in the business in the same period. Only owners were eligible respondents. Ultimately, 499 businesses were determined to be eligible, and we use the entire sample in our analysis. Please see Figures 2 for a map of business locations.
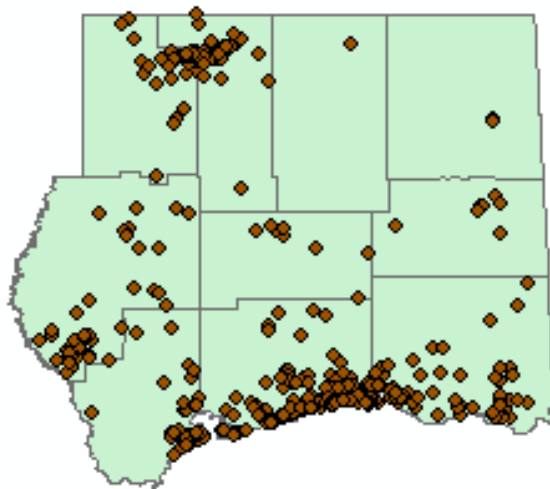

Figure 2: Locations of Businesses in Counties

Source: McDonald (2014)

Descriptive statistics for the variables of interest can be found in Table 2. We begin with a brief

discussion of three regressands. As mentioned, the entire sample includes 499 businesses. Of

these, only 153 applied for an SBA loan (the first hurdle); this is just over 30 percent of the

businesses. Of these 153, only 64 would receive a loan (the second hurdle); of the sample that

applied this is about 42 percent, and of the entire sample it is about 12 percent.

Table 2: Descriptive Statistics of Regressors

Variable	Mean	Median	Min	Max
gender	0.314	0	0	1
education	6.038	5	1	14
race	0.074	0	0	1
veteran	0.196	0	0	1
married	0.768	1	0	1
ownership	22.992	21	0	63
experience	29.208	30	0	74
home	0.3467	0	0	1
insurance	0.575	1	0	1
past	0.337	0	0	1
qual_damage	1.563	2	0	8
coast	0.675	1	0	1
employees	5.974	3	0	175
claim_home	0.836	1	0	1
claim_business	0.647	1	0	1
paid_home	0.906	1	0	1
paid_business	0.876	1	0	1
quant_damage[7]	354,237	0	0	1.30E08
revenue tier 2[8]	0.407	0	0	1
revenue tier 3	0.283	0	0	1
revenue tier 4	0.100	0	0	1
revenue tier 5	0.174	0	0	1
age of business	27.551	23	0	113

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[7] Statistics taken before variable is logged.
[8] Revenue tier 1 (omitted), less than $50,000; revenue tier 2, between $50,000 and $250,000; revenue tier 3, between $250,000 and $500,000; revenue tier 4, between $500,000 and $1 million dollars; revenue tier 5, over $1 million dollars.

These descriptive statistics are quite close to the findings of the literature discussed earlier, in which 55 percent of those who applied for a loan were denied. This suggests the potential for external validity from our conclusions.

For those who did receive a loan, the mean amount was $114,524, and the median was about half at $57,500. This suggests a fairly large variation in the amount of money received as a loan. Correspondingly, the variance is about $165,145.

5. RESULTS

The results of our regressions indicate different determinations about the loan application and receipt process at each stage. In the first stage, we examine characteristics associated with loan application. Next, in the second stage, we consider traits associated with receipt of a loan. Finally, in the third stage, we observe which of the traits included in the second stage are also associated with higher loan receipt. The full set of results can be found in Table 3.

The first stage of the model considers whether business owners apply for a loan. The results show that gender, years in the industry, perceived damage, and location on the coast increase the probability of applying for a loan, while number of years the business owner has had the business and whether the business had insurance decrease the probability of applying for a loan. This generally follows expectations. Women and coastal businesses were given preferential loan terms by the SBA, which likely increased these groups' probability of applying for loans. The experience of a business owner also increases the probability of application, as those with more experience in the industry may have more resources, which might decrease the various costs of application. Further, if a business owner perceived a high amount of damage, he or she would be more likely to apply for additional assistance from the SBA. Conversely, if a business

owner had insurance, he or she would be less likely to require additional support from the SBA. Finally, if an owner has had his or her business for many years, he or she may be less likely to apply for a loan, as over time, capital has been accumulated, allowing for liquidity that a newer business may not have.

The second stage of the model considers if the business was approved for a loan. The results indicate that number of employees, having filed and received a business insurance claim, years in the industry, some of the revenue tiers, and location on the coast increases the approval of loans, while having filed and received a residential claim decreases approval. Additionally, years in the industry and location on the coast are again significant, indicating that they are positive influences in both stages. However, the new results also generally make sense. It is interesting that having filed and received an insurance claim has contradictory effects for business and residential claims.

Finally, the third stage of the model considers the loan amount received by the business. The results indicate that revenue, age of the business, and years in the industry increase amount received, while having filed and received a residential claim decreases loan amount. Again, the experience in industry is significant. Additionally, age of the business, revenue, and industry experience of the owner, signifies stability and the ability to repay the loan, which may therefore increase the amount granted. A paid insurance claim decreases the amount received, as this suggests that some amount of the damage has already been covered and SBA loans only cover uninsured assets.

Together, these results suggest that the traits which encourage a business owner to apply for a loan are different from those which ultimately result in receipt of a loan. Although

experience in the industry seems to increase application, receipt, and amount received all

positively.

Table 3. Results from Triple Hurdle Model

	First Stage	Second Stage	Third Stage
gender	0.291***	0.078	0.219
	(0.041)	(0.326)	(0.435)
education	0.020		
	(0.015)		
race	0.068	0.084	-0.369
	(0.170)	(0.052)	(0.063)
veteran	-0.080	0.349	0.251
	(0.121)	(0.390)	(0.630)
married	-0.040		
	(0.160)		
ownership	-0.010***		
	(0.003)		
experience	0.005*	0.014***	0.008*
	(0.003)	(0.005)	(0.001)
home	-0.031		
	(0.180)		
insurance	-0.068***	0.082	-1.407
	(0.012)	(0.201)	(1.087)
past	0.074		
	(0.312)		
qualitative damage	0.235***		
	(0.090)		
coast	0.363***	0.153***	-0.156
	(0.032)	(0.020)	(0.221)
employees		0.032***	0.033
		(0.010)	(0.288)
age of business		-0.006	0.008*
		(0.010)	(0.001)
filed claim – residence		-0.268***	-0.985*
		(0.018)	(0.095)
filed claim – business		0.658***	0.170
		(0.247)	(0.704)
paid claim – residence		-0.209*	-0.577*
		(0.110)	(0.075)
paid claim – business		0.035***	0.274
		(0.012)	(0.265)
quantitative damage		-0.003	0.126
		(0.300)	(0.040)

	First Stage	Second Stage	Third Stage
	Table 3. Results from Triple Hurdle Model		
revenue tier 2		0.639**	1.644
		(0.298)	(0.425)
revenue tier 3		0.306	1.714**
		(0.283)	(0.116)
revenue tier 4		0.271	0.557
		(0.676)	(0. 328)
revenue tier 5		0.431***	1.040
		(0.111)	(0.899)
constant	-1.222***	-1.489***	9.314**
	(0.097)	(0.254)	(0.146)

*** is significant at the 99th percent level, ** is significant at the 95th percent level, and * is significant at the 90th percent level.
Standard errors are given in parenthesis.

Application for a loan is increased in probability by a variety of demographic, location, and economic factors, while actual receipt of a loan has far more emphasis on economic and stability traits.

6. CONCLUSION

Despite tremendous damage incurred in many regions following Hurricane Katrina, it is not clear what demand and supply existed for reconstruction assistance. Though many billions of dollars were pledged by the United States government, how the funding was allocated to small businesses has not always been clear. Disaster relief assistance from the SBA is one of the methods of allocation, and is intended to support families and businesses through the recovery of losses that are not otherwise insured, following catastrophic events. In this study we investigated the factors that influence the application for, approval of, and receipt of SBA disaster loans after Hurricane Katrina, using a triple hurdle model.

Results indicate that there are several characteristics which increase the application for a loan, but a set of different characteristics which determine the approval for a loan, as well as the

amount ultimately received. The only term which is significant in every stage is experience of the business owner. This suggests that no single term can determine application to approval, though having experience in the industry can improve application, receipt, and amount received.

Further, these results suggest that while some of the targeted programs for the SBA loans, including those for female, minority, and veteran business owners were not significant in influencing receipt of loans. Application for female and coastal businesses was, however, statistically significant. This suggests some lack of success in targeted SBA loan programs. In the future, improved targeting may help to improve distribution of aid to those businesses in need.

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