Diabetes and Employment Productivity: Does Diabetes Management Matter?

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Abstract
Diabetes has been shown to have a detrimental impact on employment and labor market productivity, which results in lost work days and higher mortality/disability.

This study utilizes data from an ongoing diabetes-related survey of households in Brownsville, Texas, a largely Mexican American metropolitan area on the Texas-Mexico Border, in order to assess the impact of diabetes on work productivity. We focus on two questions. First, does the management of diabetes increase productivity in the short run? Diabetes management is measured by the interaction of having diabetes and glycosylated hemoglobin levels (Hba1c). Second, are women with diabetes less productive at higher levels of earnings? Methods used include ordinary least squares (OLS), quantile regression and Heckman regression. Concerning the first question, the management of diabetes

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does not appear to have a discernible impact on labor market outcomes in the short-run. However, diabetes does negatively affect both male and female productivity. Women with diabetes are less productive at higher wage levels.

Keywords
Quantile Regression, Heckman Model, Hba1c, Labor.

Resumen
Se ha demostrado que la diabetes tiene un impacto negativo en el empleo y en la productividad del mercado de trabajo, resultando en días perdidos de trabajo, en mayores días de incapacidad y mayor mortalidad. Este estudio utiliza información de una muestra de hogares relacionada a la diabetes que está en progreso en Brownsville, Texas, la cual es un área metropolitana en gran parte México-Americana en la frontera de Texas con México, y que busca evaluar el impacto de la diabetes en la productividad del trabajo. Nos enfocamos en dos preguntas. Primero, ¿el manejo de la diabetes incrementa la productividad en el corto plazo? El manejo de la diabetes se mide como la interacción entre tener diabetes y los niveles de hemoglobina glicosilada (Hba1c).

Segundo, ¿son menos productivas las mujeres con diabetes a altos niveles de ingresos laborales? Los métodos utilizados incluyen Mínimos Cuadrados Ordinarios (MCO), regresiones cuantílicas y la regresión de Heckman. En relación a la primera pregunta, el manejo de la diabetes no parece tener un impacto discernible en el corto plazo sobre los resultados en el mercado de trabajo. Sin embargo, la diabetes afecta negativamente la productividad tanto de la mujer como del hombre. Las mujeres con diabetes son menos productivas a niveles salariales más altos.

Palabras clave
Regresión cuantílica, Modelo de Heckman, Hba1c, Trabajo.

Introduction

Diabetes is a disease which has economic implications. The American Diabetes Association estimates that diabetes costs the U.S. economy $132 billion per year (American Diabetes Association 2003). An important part of these costs are labor productivity losses (Bastida & Pagán 2002, Brown III, Pagán & Bastida 2005, Kahn 1998, Ng, Jacobs & Johnson 2001, Lavigne, Phelps, Mushlin & Lednar 2003). Further, the US Census Bureau estimates that from 2002 to 2020 the number of individuals diagnosed with diabetes will increase by 44 percent to 17.4 million (American Diabetes Association 2003). With the prevalence and incidence of diabetes increasing, accurate estimates of the labor market cost of diabetes are important in order to develop appropriate health policy responses.

Given the high economic costs of diabetes (American Diabetes Association 2003), public health officials have been arguing that diabetes prevention is important. Prevention could mean one of two things: The prevention of the onset of diabetes, or the prevention of diabetes-related problems through the management of glycosylated hemoglobin levels (Hba1c) for people already diagnosed with diabetes. If the productivity costs of diabetes when diabetes is managed are low, scarce prevention dollars could be concentrated on the much smaller subpopulation already diagnosed with diabetes. On the other hand, if the costs associated with diabetes are substantial, whether managed or not, then prevention dollars must be spread over the much larger general population. Of course, it is likely that dollars should be spent on both preventing the onset of diabetes as well as its management after onset. However, there is currently no information to inform policy-makers on how to apportion scarce prevention dollars between diabetes onset and diabetes management.

The labor market component of the overall cost of diabetes is important. However, while overall diabetes-related costs are rising, it is not clear that per capita labor costs associated with diabetes are increasing. Technological changes over the last three decades have led to changes in the labor market and in the medical field. First, there are increases in the number of jobs that are less physically demanding and therefore accessible to persons with diabetes (Kahn 1998). Second, new drugs, glycosylated hemoglobin levels (Hba1c) monitoring devices and food science advances, such as artificial sweeteners, are also making diabetes "management" easier and less costly than before.

Brown, Pagán and Bastida show that the effects of diabetes on work propensity are more important for men than for women (Brown III et al. 2005). Anecdotally, many believe that women are more inclined to manage their diabetes through physician visits, diligent use of pharmaceuticals, use of monitoring devices and health behavior modification. This would explain why they have less diabetes-related labor market problems in comparison to men. With the laboratory-measured Hba1c data in our study, we can test this hypothesis.

This study adds two important elements to the growing literature on diabetes and labor market outcomes. First, we examine whether poor diabetes management is the cause of adverse labor market outcomes rather than diabetes per se. In our data, Hba1c levels are measured in a laboratory for all participants, whether or not they have been diagnosed with diabetes by a physician. Thus, we know the extent to which persons with diabetes have managed their Hba1c. Second, we examine whether diabetes affects labor productivity, whether managed or not, across wage levels using quantile regression.

We used microdata from the Diabetes Impact Project, an ongoing survey from a predominantly Mexican American area of South Texas. Our data has important advantages. The Diabetes Impact Pro ject surveys Mexican Americans, a population which has a high prevalence and incidence of diabetes. The percentage of this population diagnosed with this health condition is expected to rise from 1.4 million in 2002 to 2.9 million in 2020, a 107 percent increase (American Diabetes Association 2003). By contrast, the total US population diagnosed with diabetes is expected to increase by 44 percent during the same time period. Our data also has laboratory-measured Hba1c levels, necessary for the assessing the level of blood sugar management for persons with diabetes.

Diabetes Self-Management and Health Capital

One of our main hypotheses is that unmanaged diabetes is correlated with labor productivity. Michael Grossman argued that "health capital" is a measure of health stock, reflective of past health behavior (Grossman 1972). If a person jogs or changes their diet, for instance, their health stock does not instantly change. However, jogging and dietary changes maintained over a long period increase his/her health stock. Further, if a person temporarily stops jogging or occasionally eats unhealthy food after a long period of adherence, his/her health stock will not be greatly affected. Of course, the Grossman model maintains that healthy behavior requires time inputs (Grossman 1972).

Hemoglobin is a protein which is found in red blood cells. Like a canary in a coal mine, hemoglobin in red blood cells reveal the level of blood glucose over a two to three month period. The greater the percentage of sugar that is the blood supply, the higher the percentage of hemoglobin has been glycosylated. Note that the percentage of hemoglobin that is glycosylated is invariant to day-to-day blood sugar levels (Woerle, Pimenta, Meyer, Gosmanov, Szoke, Szombathy, Mitrakou & Gerich 2004). Thus, it is an excellent measure of health stock in the Grossman sense (Grossman 1972).

The American Diabetes Association defines type 2 diabetes as managed based on glycosylated hemoglobin levels (Hba1c) (http://www.diabetes.org/diabetes-research/summaries/woerle-ogtt.jsp). Hba1c levels of seven percent or less indicates that the person with diabetes is managing his or her diabetes.

Among persons without diabetes, lower Hba1c levels should not be correlated with labor market success. On the other hand, among persons diagnosed with diabetes, labor productivity for persons with low Hba1c levels should be higher than for persons with high Hba1c levels. An alternative hypothesis is that time and effort expended on managing diabetes may come at the expense of current, short-run labor productivity. Thus, it may be that efforts to manage diabetes lower productivity in the short-term.

Our strategy to test the hypothesized association of low wages with unmanaged diabetes involves creating an interaction term between diabetes and Hba1c levels. For persons without diabetes, the interaction term value is zero. For person with diabetes, the interaction term will be their Hba1c. Therefore, those who have managed their diabetes will have an interaction term value of seven or lower, those who have not managed their diabetes will have an interaction term value of greater than seven. We expect to find a negatively relationship between this interaction term and log wage.

Data and Methods

The data for this study comes from an ongoing survey in Brownsville, Texas, a metropolitan area with a total population of 139,722 in 2002 that is located in the US-Mexico border region (U.S. Census Bureau 2006). Brownsville is the most southernmost city in Texas and 91.3% of its population is of Hispanic origin (U.S. Census Bureau 2006).

Brownsville, as many other Texas border cities, is characterized by high poverty levels and low educational attainment. For example, 36.5% of people in Cameron County, where Brownsville is located, live below the poverty level (which ranks it next to last in the country). Only 60% of the population 25 years and over have completed high school (which ranks it last in the country). Approximately 46.5% of children under 18 years are below the poverty level, which ranks it next to last in the country (http://www.census.gov/acs/www/Products/Ranking/2003/R01T050.htm).

Even though median household incomes in Brownsville are among the very lowest in the country, there is variation. Therefore, the Diabetes Impact Study selected a representative sample based on income for the Mexican-American population of Brownsville. To do so, we selected census blocks from census tracts with median household incomes in the first and the third quartiles.[1] The 2000 United States Census of Population and Housing was used to select the probability sampling frame. A multi-stage cluster sample of participants is being collected in these two Brownsville area locations and it is expected to be complete by the beginning of 2008.

Within all randomly selected clusters (census blocks), all the households in the census block are contacted. A participant, between 35 to 64 years old, from each household is randomly selected using a ten digit permutation algorithm.

Heckman Model

Brown III, Pagán & Bastida (2005) show that especially for Mexican-American men, diabetes affects work propensity. For persons not working the wage is missing due to selection. Therefore, in order to account for

[1] *Note that households selected within the census tracts may have differing income levels.*

sample selection bias, we also estimate the log wage equation using the method of Heckman. Following Greene (1990), let $z = 1$
when the wage is known, $z = 0$ otherwise. Then, a probit model

$$z_i^* = c_i'\delta + Diab_i \times Hba1c_i\gamma_1 + u_i, u \sim N[0,1], \quad (1)$$

$$z = 1 \text{ if } z^* > 0, \quad (2)$$

$$z = 0 \text{ if } z^* \leq 0,$$

$$Prob[z = 1] = \Phi(c_i'\delta + Diab_i \times Hba1c_i\gamma_1),$$

$$Prob[z = 0] = 1 - \Phi(c_i'\delta + Diab_i \times Hba1c_i\gamma_1)$$

estimates the probability that wage is observed. In (1), ci is the vector of exogenous variables related to observing wage and δ is the corresponding vector of coefficients. $Diab_i \times Hba1c_i$ is the interaction term and γ_1 is the associated coefficient. Note that diabetes may be related to whether the person earns a wage or not because he or she may select out of the market.

The Heckman model is a two-stage model, where equation (1) is the first stage. Then, the log wage equation is estimated in the second equation as,

$$Log\ Wage = x_i'\beta + Diab_i \times Hba1c_i\gamma + e_i, \text{ observed only if } z = 1, \quad (3)$$

$$(u, e) \sim \text{bivariate normal}[0, 0, 1, \sigma_e, \rho]$$

where ρ is the correlation between e_i and u_i and σ_e is the variance of the disturbance (1).
Vector x_i is the exogenous variables related to wage and β is the corresponding vector of coefficients.

It is shown in Greene (1990) and elsewhere that

$$E[Log\ Wage|z_i = 1] = x_i'\beta + Diab_i \times Hba1c\gamma + \rho\sigma_e\lambda(c_i'\delta + Diab_i \times Hba1c_i\gamma_1), \quad (4)$$

where $\lambda = \phi(c_i'\delta + Diab_i\gamma_1)/\Phi(w_i'\delta + Diab_i\gamma_1)$ is the inverse Mills ratio. ϕ is the marginal probability from the normal distribution and Φ cumulative probability from the normal distribution.

Quantile Regression

We estimate log wage quantile regressions for the following equation,

$$Log\ Wage = x_i'\beta + Diab_i \times Hba1c\gamma + e_i, \quad (5)$$

where $Diab_i$ is the dummy variable defined above and $Diab_i \times Hba1c_i$ is the interaction term (Koenker & Hallock 2001). Vector x_i is the exogenous variables related to wage and β is the corresponding vector of coefficients, as defined in (3). Other versions of (5) that will be estimated include the diabetes dummy variable without the interaction term.

Quantile regression is useful for two reasons. First, diabetes and managed diabetes may affect productivity differently at different levels of the wage distribution. Second, our data is highly compressed at the low end of the wage distribution and wages may be constrained from falling further due to diabetes.

We estimate the simultaneous quantile regression with the ‘sqreg’ function in Stata Version 8 (Stata 2003). Confidence intervals are constructed at each quantile via boot-strapping. The quantiles selected are from .05 to .95, in steps of 0.05. Thus, 19 simultaneous quantile regressions were estimated.

Results

Table 1 reports the descriptive statistics of the variables used in the OLS, Heckman, and quantile regressions by gender. Note that women are less likely to be employed and have

Table 1: Descriptive statistics, by gender

			Men		
Variable	*n*	Mean	S.D.	Min	Max
Log hourly wage	121	2.119	.523	1	4
Employed (1=yes; 0=no)	205	.722	.449	0	1
Age	205	47.195	9.564	21	64
Age squared	205	2,318	919	441	4,096
Born in Mexico (1=yes; 0=no)	205	.659	.475	0	1
Years of schooling	205	10.307	4.302	0	20
Years residing in Brownsville (US)	205	21.868	17.399	0	63
Married (1=yes; 0=no)	205	.600	.491	0	1
Log of other household income	205	2.871	4.338	0	13
Diabetic×Hba1c	190	1.367	3.577	0	16
Diabetic (1=yes; 0=no)	205	.166	.373	0	1
“New” Diabetic (1=yes; 0=no)	205	.044	.205	0	1

			Women		
Variable	*n*	Mean	S.D.	Min	Max
Log hourly wage	177	1.947	.479	1	4
Employed (1=yes; 0=no)	434	.482	.500	0	1
Age	434	47.256	8.934	35	64
Age squared	434	2,313	868	1225	4,096
Born in Mexico (1=yes; 0=no)	434	.721	.449	0	1
Years of schooling	434	9.028	4.218	0	20
Years residing in Brownsville (US)	434	21.811	15.851	0	64
Married (1=yes; 0=no)	433	.517	.500	0	1
Log of other household income	433	5.164	4.562	0	12
Diabetic×Hba1c	408	1.336	3.647	0	19
Diabetic (1=yes; 0=no)	434	.136	.343	0	1
“New” Diabetic (1=yes; 0=no)	434	.041	.200	0	1

slightly less schooling than men, and are more likely to be immigrants. Men are also paid more than women.

Approximately four percent of women and men not previously diagnosed with diabetes had fasting glucose levels above 126 mg/dl. This is the variable labeled “New Diabetic.” Although a second reading would be necessary to officially diagnose diabetes, the vast ma jority of them likely have diabetes and have therefore been diagnosed for the first time by the medical personnel in our survey.

Table 2: Self-management of Diabetes, by gender

Var	*n*	Mean	S.D.	Min	Max
			Women		
Hba1c	54	10.1	3.5	4.7	18.9
Blood sugar	59	200.98	82.04	74.3	434
			Men		
Hba1c	26	9.98	2.7	5.8	16.2
Blood sugar	34	189.02	73.7	84.1	
332.5					

Of people with diabetes, women are no more likely to have their Hba1c managed in comparison to men. However, neither gender appears to be managing their diabetes effectively.

Based on our previous research (Brown III et al. 2005), we also estimated the correlation between the interaction term and our instruments (family history of diabetes) using a tobit model (not reported). However, unlike the correlation between diabetes status and family history of diabetes, the correlation between the interaction term and family history of diabetes was weak.[2] This is likely because although genetics explains much of the variation of whether a person develops diabetes, diabetes-related genetics does not explain whether a person with diabetes is able to have it managed. Due to the weak correlation between our instruments and our interaction term, we will not use instrumental variable techniques to examine diabetes management.

OLS and Heckman Models

Table 3 reports the estimates for the OLS regression for men, assuming that diabetes is exogenous. Let us first consider the model in the leftmost columns, where diabetes management is considered. Age and age squared

[2] *The results are available upon request.*

is related to working and productivity in a non-linear fashion. Being born in Mexico has a negative effect on wages. The variable

Table 3: OLS model of log wage, Men

Variable	Coefficient		Std. Err.	Coefficient		Std. Err.
	Log hourly wage					
Age	- 0.105	**	0.051	-0.107	**	0.049
Age squared	0.001	**	0.001	0.001	**	0.001
Born in Mexico (1=yes; 0=no)	-0.279	**	0.137	-0.260	**	0.126
Years of schooling	0.031	**	0.013	0.033	**	0.012
Years residing in Brownsville (US)	-0.004		0.004	-0.003		0.004
Married (1=yes; 0=no)	0.181	*	0.101	0.170	*	0.096
Diabetic×Hba1c	-0.019		0.018			
Diabetic (1=yes; 0=no)				-0.278	*	0.151
Constant	4.169	***	1.176	4.207	***	1.152

Significance levels: *: 10% **: 5% ***: 1%

'years of schooling' is positively related to wage. Being married is positively related to wage at the 10% level. Finally, the variable 'years in Brownsville' is negatively related to log wage. For most people, the number of years residing in Brownsville is synonymous with the number of years in the United States. The negative sign likely reflects the fact that the border area is a temporary place of residence for many Mexican Americans. Many who develop language and other work skills move away from the border to places in the U.S.

Diabetes management (the interaction term, Diabetic×Hba1c) coefficient is negatively related to log wage, but the association is not statistically significant at this level of power. However, this suggests that diabetes has a detrimental effect on productivity, even when managed. Let us now consider the model in the rightmost columns, where diabetes per se is considered. Diabetes is negatively related to log wages. The wage premium is quite high–having diabetes lowers wages by 28%.

In order to take sample selection into account, let us now turn our attention to the Heckman model estimates in Table 4. Age and age squared are now not significantly related to log wage. In both the selection equation and the wage equation, the diabetes Hba1c interaction term is significantly and negatively related to working and negatively related to log wage. Further, the magnitude of the effect of the diabetes Hba1c interaction term is approximately twice the effect when sample selection is not taken into account.
For each unit increase of Hba1c for persons with diabetes, log wage declines by four percentage points.

Even though diabetes management is negatively associated with productivity, diabetes status has a stronger association. After accounting for sample selection, the negative effect of diabetes on productivity increases by approximately 50%, from 28% to 42%.

Note that diabetes is negatively related to earning a positive wage. Being married is positively related to earning a positive wage; Log of other household income is negatively related to earning a positive wage.

Table 4 also includes a likelihood ratio test of the covariance between ei and u_i, defined as ρ in equation (3). In each specification of the model, the error terms are correlated at the 10% level. This indicates a bivariate normal distribution of the sample selection and log wage equations. Therefore, the Heckman estimates are warranted.

Table 5 reports the estimates for the OLS regression for women, assuming that diabetes is exogenous. Only the variables ‘years of schooling’ ‘years in Brownsville’ are positively related to wage. Being married is positively related to wage at the 10% level.

Diabetes management (the interaction term, Diabetic×Hba1c) coefficient is negatively related to wage, but not statistically significant. This suggests that diabetes has a detrimental effect on productivity, even when managed. The results are similar to those for men. Diabetes per se

Table 4: Heckman model of log wage, Men

Variable	Coefficient		Std. Err.	Coefficient		Std. Err.
	Log hourly wage					
Age	- 0.069		0.056	- 0.081		0.055
Age squared	0.001		0.001	0.001		0.001
Born in Mexico (1=yes; 0=no)	- 0.269	*	0.146	-0.282	**	0.135
Years of schooling	0.027	**	0.014	0.028	**	0.013
Years residing in Brownsville (US)	-0.003		0.004	- 0.003		0.004
Married (1=yes; 0=no)	0.291	***	0.108	0.289	***	0.104
Diabetic×Hba1c	- 0.040	**	0.018			
Diabetic (1=yes; 0=no)				- 0.422	***	0.158
Constant	3.193	**	1.316	3.506	***	1.278
	Wage Observed (1=yes; 0=no)					
Age	0.174		0.118	0.146		0.117
Age squared	-0.002	*	0.001	- 0.002		0.001
Born in Mexico (1=yes; 0=no)	- 0.197		0.279	-0.290		0.266
Years of schooling	0.014		0.026	0.007		0.025
Years residing in Brownsville (US)	-0.004		0.008	-0.006		0.008
Married (1=yes; 0=no)	0.751	***	0.206	0.805	***	0.201
Log of other household income	-0.075	***	0.023	- 0.079	***	0.022
Diabetic×Hba1c	-0.074	**	0.030			
Diabetic (1=yes; 0=no)				-0.638	**	0.280
Constant	-3.251		2.749	-2.455		2.725
$H_0: \rho = 0$	(X^2 (1) = 3.08, Prob = 0.079			X^2 (1) = 3.27, Prob = 0.071		

Significance levels: *: 10% **: 5% ***: 1%

Table 5: OLS model of log wage, Women

Variable	Coefficient	Std. Err.	Coefficient	Std. Err.
	Log hourly wage			
Age	0.011	0.051	0.030	0.050
Age squared	- 0.000	0.001	- 0.000	0.001
Born in Mexico (1=yes; 0=no)	- 0.071	0.085	- 0.064	0.083
Years of schooling	0.020 **	0.009	0.024 ***	0.009
Years residing in Brownsville (US)	0.009 ***	0.003	0.009 ***	0.003
Married (1=yes; 0=no)	0.091	0.069	0.067	0.068
Diabetic×Hba1c	- 0.014	0.009		
Diabetic (1=yes; 0=no)			- 0.160	0.099
Constant	1.284	1.181	0.828	1.165

Significance levels: *: 10% **: 5% ***: 1%

is negatively related to log wages, but not at any statistically significant level. The wage premium is much lower than for women.

Table 6 shows the Heckman results for women. The likelihood ratio test of whether ρ , which is the correlation between e_i and u_i in (3), is significantly different from zero does not reveal a difference. Therefore, the results for the wage equation are again equivalent to OLS estimates with no selection.

Quantile Regression

In order to consider the effect of diabetes management on productivity, we estimate log wage quantile regressions. Figures 1, 2, and 3 display the results. For each (A) figure (on the left), the line represents the diabetes coefficient estimate and its 95% confidence interval for each quantile of log wage. These are from equation (5). The dotted line is the zero coefficient. For each (B) figure (on the right), the line represents the diabetes Hba1c interaction coefficient estimate and its 95% confidence interval for each quantile of log wage. These are from equation (5). Note that the other regressor are the same as above (Constant, Age, Age squared, Born in Mexico (1=yes; 0=no), Years of schooling, Years residing in Brownsville (US), Married (1=yes; 0=no)).

Table 6: Heckman model of log wage, Women

Variable	Coefficient		Std. Err.	Coefficient		Std. Err.
	Log hourly wage					
Age	0.004		0.050	0.025		0.050
Age squared	0.000		0.001	0.000		0.001
Born in Mexico (1=yes; 0=no)	-0.078		0.084	-0.068		0.081
Years of schooling	0.019	**	0.009	0.023	***	0.008
Years residing in Brownsville (US)	0.009	***	0.003	0.009	***	0.003
Married (1=yes; 0=no)	0.100		0.068	0.075		0.068
Diabetic×Hba1c	-0.014		0.009			
Diabetic (1=yes; 0=no)				-0.163	*	0.097
Constant	1.511		1.194	0.996		1.182
	Wage Observed (1=yes; 0=no)					
Age	0.143		0.090	0.151	*	0.088
Age squared	-0.002	*	0.001	-0.002	*	0.001
Born in Mexico (1=yes; 0=no)	0.051		0.172	0.042		0.165
Years of schooling	0.024		0.018	0.026		0.017
Years residing in Brownsville (US)	0.002		0.005	0.001		0.005
Married (1=yes; 0=no)	0.185		0.141	0.130		0.137
Log of other household income	-0.109	***	0.015	-0.108	***	0.015
Diabetic×Hba1c	0.012		0.019			
Diabetic (1=yes; 0=no)				0.205		0.193
Constant	-3.104		2.127	-3.320		2.081
$H_o: \rho = 0$	X^2 (1) = 0.52 Prob= 0.4704			(X^2 (1) = 0.27 Prob = 0.6064		

Significance levels: *: 10% **: 5% ***: 1%

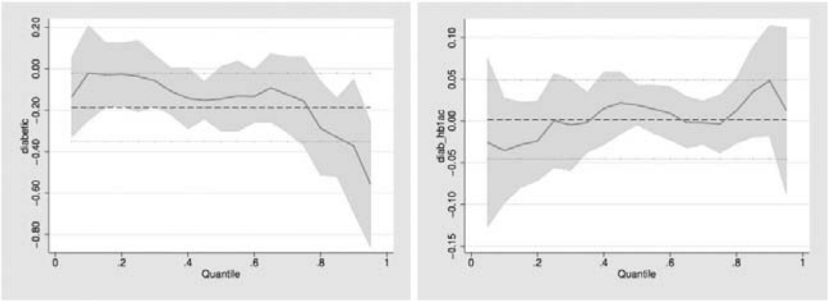
Let us first consider the effects of diabetes on men and women combined, as shown in column A of Figure 1. The results show that the detrimental effects of diabetes are higher at the higher wage quantiles. This could indicate that 'left wall' effects at the low end of the wage because they are already at the lowest possible wage for their profession.

As shown in column B of Figure 1, when the interaction term is included rather than the diabetes dummy, most of the detrimental effects

on labor productivity disappear.
low end of the wage distribution may be less productive than persons distribution. In reality, persons with diabetes (managed or not) at the without diabetes, but this does not translate to wages

This indicates that persons with diabetes who have managed their diabetes are no more productive than persons with diabetes who have not managed their diabetes. Note that when the diabetes dummy and the interaction term are both included, neither affects diabetes at any portion of the log wage distribution.

Figure 1: Men & Women: (A) Diabetes (B) Diabetes×Hba1c



Let us now consider women, as shown in Figure 2. Column A of Figure 2 illustrates

Figure 2: Women: (A) Diabetes (B) Diabetes ×Hba1c

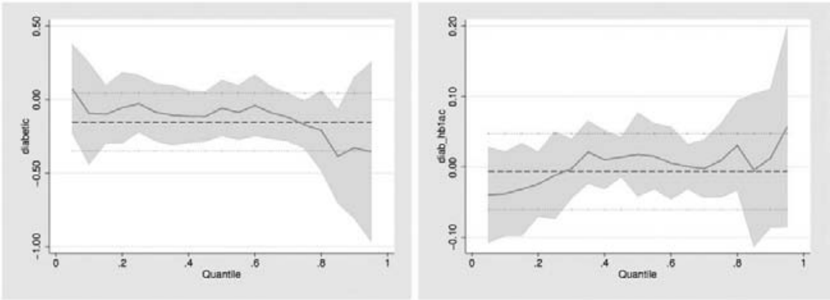
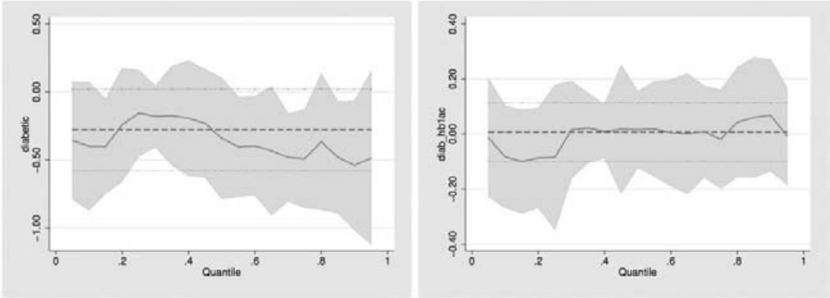


Figure 3: Men: (A) Diabetes (B) Diabetes ×Hba1c



the estimates of diabetes on labor productivity. This indicates that the detrimental effects of diabetes are higher in the higher wage quantiles. However, when Hba1c management is taken into account, most of the detrimental effects of diabetes on labor productivity disappear. Note that when the diabetes dummy and the interaction term are both included, neither affects diabetes at any portion of the log wage distribution.

For men, as shown in Figure 3, diabetes has a large effect on productivity, whether or not we include the diabetes dummy or the interaction term. However, the effects do not differ by the quantile of the wage.

4 Discussion and Conclusion

Our results reported above are inconsistent with previous research suggesting that diabetes mainly affects the labor market of men, but not women (Bastida & Pagán 2002, Brown III et al. 2005). Our results using quantile regression reveal that at the high end of the wage distribution, the productivity of females with diabetes is lower than for females without diabetes. This is possibly due to the fact that women with diabetes earn wages near the left-wall of the wage distribution.

Our results for Hispanics also are higher quantitatively than previous research. For males, the wage productivity premium for avoiding diabetes is approximately 42%. For those with diabetes, there is an approximately four percentage point wage premium for every unit of Hba1c increase. Our results suggest that in order to avoid productivity losses for males associated with diabetes, scarce prevention resources should be spent on the prevention of onset of diabetes rather than the management of Hba1c for those already diagnosed with diabetes.

Unfortunately, this means resources must be spread among populations most predisposed to diabetes, such as Hispanics, rather than concentrated on the smaller group with diabetes. This is not to say that management of diabetes will not improve quality of life or prevent medical costs in the future. Productivity in the future will likely be higher for those who currently are managing their diabetes.

Our results on self-management of diabetes are valid in the short-run only. The Grossman model suggests that health capital leads to long-run productivity gains. However, we only compare short-run effects of diabetes management with cross-section data.

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