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Title:

Dynamics of the bodyweight-wage relationship in emerging countries: Evidence from Mexico.

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Abstract:

This article explores the dynamics of the relationship between bodyweight and wages in Mexico, an emerging country with high obesity prevalence. For this empirical study, we used observational panel data from the Mexican Family Life Survey (2002-2012). First, we descriptively investigated the relationship between body weight and wages and its dynamics across time. We then implemented a difference-in-differences design that performs estimates robust to time-invariant heterogeneity. Our results show that the relationship between bodyweight and hourly wages depends on gender, time and occupation status. While the results revealed significant wage penalties across time for overweight service workers, we observed a relative acceptance of excess weight in other employment sectors, especially among high-skill jobs. Consequently, our results have important implications for public policies.

Keywords: Mexico; Overweight; Obesity; Wages; Difference-in-differences.

JEL codes: O15; I12; C21

1. Introduction

In recent decades, the number of people with overweight has rapidly increased around the world. This phenomenon led some authors to assess the repercussion of body mass on unemployment and earning penalties, since the labor market is a key sector of economic performance and an important dimension of social well-being (Cawley, 2004). The empirical literature suggests that the impacts of body weight on professional success depend on the level of development of the country concerned. For instance, several authors note that the effect of body weight on earnings is generally negative in rich economies, especially in the service sector and for highly-skilled women, despite differences across ethnicity (Cawley, 2004; Sarlio-Lahteenkorva, Silventoinen, & Lahelma, 2004; Brunello & D'Hombres, 2007; Johar & Katayama, 2012; Pinkston, 2017).¹ Besides potential productivity losses induced by physical morbidities and diseases associated to overweight, these findings can be explained by the Western perception of weight. In these countries, obese people are generally perceived as lazy, slow, incompetent, unattractive and lacking rigor (Puhl & Heuer, 2009). According to Puhl & Brownell (2006) and Major et al. (2014), the widespread of overweight and obesity in society contributes to increase exposure to weight-based stigma and discrimination. Further, Brewis (2014) mentioned the occurrence of a self-reinforcing cycle that can amplify both emotional suffering (induced by weight-based stigma) and weight gain.

In contradictory fashion, more recent research shows that the relationship between weight and labor market outcomes is changing in rich economies where overweight is predominant, such as England and Germany (Barbieri, 2018; Kropfhäuser & Sunder, 2015). Using different identification strategies, these authors observed a U-inverted relationship in the two countries, by detecting an overweight premium in terms of access to employment and wages, especially in non-manual activities (i.e. service and high-skill jobs). As suggested by psychosocial studies, the current change might be due to an increasing misperception of

overweight given the normalization of this bodyweight status in society (Robinson & Christiansen, 2014). Along with these potential social changes, the introduction of e-technologies (e.g. smartphones, tablets) and new production methods (e.g. teleworking) make obese workers each time more adapted to the labor market. Indeed, technological changes may improve labor market participation and productivity of excess weight and sick individuals, insofar as such transformations decrease the share of physically demanding tasks (Philipson & Posner, 1999).

Interestingly, the relationship between weight and labor market outcomes is fundamentally different in developing countries. Since hunger-related issues are still important in the poorest and traditional economies, fat people are usually considered as being the most attractive because high body mass symbolizes health, strength, wealth, and prosperity (Renzaho, 2004). In fact, in poor economies, being overweight or obese is not particularly associated with income penalties. Moreover, in some activities and sociocultural contexts, bodyweight tends to improve earnings and employment status, especially for men (Poulain, 2017). This is the case in sub-Saharan African countries such as Guinea, Ivory Coast, Ghana and Ethiopia (Glick & Sahn, 1998; Kedir, 2008; Schultz, 2003). In contrast, the relationship between body weight and labor market outcomes appears to be more ambiguous in middle-income countries. Given the coexistence of hunger and obesity in these countries, some authors assume a U-inverted relationship between body mass and labor outcomes. According to this hypothesis, underweight and overweight workers would be the lowest paid and the least employed because of their low level of productivity due to physical and/or mental comorbidities. In addition, urbanization and the growing diffusion of thinness ideals through media potentially contribute to increase weight-based stigma and job-related penalties in emerging countries (Brewis et al., 2018; Cohen et al., 2013). In line with these hypotheses, Shimokawa (2008) reported that underweight and overweight workers are the lowest paid in

China, while normal-weight workers earn the highest wages. More recently, analyzing the impact of body mass on employment probability in China, Pan, Qin, & Liu (2013) found the same U-inverted relationship: normal-weight adults are more likely to work than their thinner and fatter counterparts.

Although the literature suggests a U-inverted relationship between bodyweight and professional success in middle-income economies, this group of countries is quite heterogeneous in terms of nutritional issues. For example, obesity prevalence is three times higher in Mexico than in China. Consequently, besides heterogeneous labor markets and weight-based productivity levels, it is likely that different nutritional contexts lead to different perceptions of weight and, by extension, to different effects of body mass on labor market outcomes. In a comparative study focusing on middle-income countries, Clément et al. (2020) observed that, while excess weight is still rewarded in the Indian labor market, overweight and obesity are strongly penalized in the Chinese labor market. In contrast, they find an overweight wage premium in manual jobs and no effect in non-manual jobs in Mexico. More specifically, Levasseur (2019b) noted different wage effects regarding the severity of excess weight in Mexico. While overweight status might not be significantly penalized in the Mexican labor market, obesity status is associated with important wage losses among women working in the service sector. Therefore, compared to India and China, Mexico seems to be characterized by an ambivalent situation regarding the weight-wage association, highly dependent on gender and occupation type. This ambivalence concords with recent theories formulated in the anthropological literature, suggesting the co-occurrence of *pro-fat* and *anti-fat* social norms in emerging countries (Brewis, SturtzSreetharan, & Wutich, 2018). This proposition appears particularly relevant for middle-income countries such as Mexico where overweight has become the physical norm (i.e. around one-third are obese and two-thirds are overweight). Indeed, despite the wide diffusion of the Western thin ideal around the world,

through the cultural globalization process, *pro-fat* social norms may persist in Mexico, especially among the most vulnerable social groups (Bargain & Zeidan, 2019). Furthermore, recent studies support the assumption that the generalization of overweight in Mexican society leads to social acceptance of excess weight (Prina & Royer, 2014), as observed in England and Germany (Barbieri, 2018; Kropfhäuser & Sunder, 2015). Hence, based on the three waves of the Mexican Family Life Survey (MxFLS, 2002, 2005-06 and 2009-12), in this paper, we explore potential changes across time in the weight-wage relationship in Mexico. Compared to previous studies based on Mexico, this study shows its originality by focusing on within-individual variations rather than between-individual variations. This approach is particularly relevant insofar as it allows to capture potential changes in fat-related social norms and work-based innovations, which might occur at the beginning of the second millenary in Mexico.

To explore the dynamics of the relationship between weight and wages across time (between 2002 and 2012), we used a two-step empirical strategy. First, we implemented a descriptive analysis by running cross-sectional semiparametric estimations. Such estimations have the advantage of graphically illustrating an unknown relationship and the changes it undergoes across time, without imposing any functional form. Once we had a better idea of its functional form, we used ordinary least squares (OLS) parametric estimations to check the significance of the results of the semiparametric model. Note that both semiparametric and parametric estimations are controlled for in a comprehensive set of productivity-related factors (e.g. age, education, cognitive scores) and other sociodemographic covariates (e.g. marital status, living area). Second, to identify an effect under certain assumptions, we estimated a difference-in-differences (DD) model based on wage gaps between excess weight and thinner workers across time. We also investigated potential heterogeneity according to gender, survey rounds and occupation groups.

One could consider that our study period (2002-2012) is too short to identify significant changes in the relationship between weight and wages. Notwithstanding, not only innovations improving the productivity of overweight workers is likely to occur during this 10-year period (e.g. smartphones, teleworking), but we are also optimistic about the widespread emergence of new fat-related social norms. Comparing studies that focus on the 1990s with more recent research, we observed that the relationship has evolved considerably in a few years. It will be recalled that Kropfhäuser & Sunder (2015) and Barbieri (2018) found an overweight premium for men and women on the German and English labor markets in the 2000s, whereas older studies describe quite different stories. For example in the 1990s, Cawley, Grabka, & Lillard (2005) found no significant relationship in Germany. In the same period in England, Morris (2007) observed a negative effect of obesity on employment probability. This means that deep changes have taken place in these countries in just over one decade. Note that most of these authors attribute these changes to social changes. Consequently, it is likely that major fat-related social changes have also occurred during a 10-year period in Mexico, which is an emerging country characterized by strong geographical, commercial and cultural proximity to the US.

Our empirical application emphasizes the co-occurrence of *anti-fat* and *pro-fat* social norms in the Mexican labor market. The main evidence concerns the wide diffusion of *new anti-fat* norms in the service sector. Indeed, controlling for time-invariant heterogeneity, municipality fixed effects and several covariates, we found that weight gain significantly reduced hourly wages, especially for service workers between 2002 and 2005-06. The results also suggest the diffusion of *new pro-fat* social norms in the highest positions. Not only the descriptive analysis indicates an increasing positive correlation across time between bodyweight and wages for high-skilled workers, but also the identification strategy indicates a non-significant wage increase for excess weight highly skilled workers compared to their

thinner counterparts. Besides a potential introduction of new technologies making overweight workers more productive in high-skill occupations, this latter result may also suggest an increasing acceptance of excess weight given the overrepresentation of overweight and obesity in this job category. Finally, the results concerning manual workers are less clear. This is not surprising since DD estimates do not capture time-invariant variations. Hence, one can assume that manual workers are attached to *pro-fat* social norms due to past deprivations and traditional beliefs, which theoretically remain relatively stable over time.

The rest of this article is organized as follows: Section 2 describes the conceptual framework by listing the fundamental pathways through which weight and wages may be linked; Section 3 details the empirical strategy; Section 4 presents the results, and Section 5 discusses the main findings and concludes.

2. Conceptual framework

2.1. Pathways in the relationship between weight and wages

In line with the health economics literature and development studies, we consider that bodyweight and wages may be linked by two inverse relationships. The first link direction concerns the effects of income, and more globally socioeconomic status, on lifestyles, food consumption and then bodyweight. For literature surveys about this relationship, see Sobal & Stunkard (1989), Monteiro, Conde, Lu, & Popkin (2004) and McLaren (2007). The literature suggests that the effect of socioeconomic status on bodyweight changes from a positive trend to a negative trend in line with economic development. Indeed, in poor and traditional societies where food is relatively scarce, the social elite is fatter because excess weight is a sign of health, wealth and power and helps to climb the social scale. By contrast, in rich countries, wealthier people are thinner than the poorest. Not only because richer people have better access to healthy (and expensive) food, sport facilities and education, but also because

poor people suffer from time inconsistencies by preferring immediate and certain satisfaction (by high-fat and palatable calorie intakes and limited physical activity) than investing in the future and uncertain health (Levine, 2015). However, the relationship between socioeconomic status and bodyweight is not so clear-cut in emerging countries (McLaren, 2007). As observed in several emerging economies, a recent study reported a nonlinear relationship in Mexico (Levasseur, 2015). The results of that study show that the highest social class (in terms of income, education and employment status) has a higher risk of central adiposity than the poorest group, whereas the lower-middle class is the most threatened by abdominal fat accumulation. The author assumes that the wealthiest individuals have stressful and screening extensive jobs associated with risky food behaviors and little free time (regular consumption of prepared meals and fast food, screening leisure, etc.), which lead them to gain weight. By contrast, compared to the poorest households, lower-middle class households have higher incomes enabling better food accessibility and diversity. Nonetheless, compared to the upper middle class, the lower middle class remains relatively poor. Yet poor households are generally less sensitive to healthy lifestyles, probably because of the lack of educational opportunities and a misunderstanding of human capital investment returns.

The second link direction refers to how bodyweight affects wages. It is this causal relationship that motivates this article. Based on the health economics literature, we consider two main pathways that may explain how overweight affects earnings: weight-related productivity loss and weight-related social norms (Cawley, 2004, 2015). Overweight and obesity statuses are not only associated with poor physical abilities, but also with various non-transmissible diseases (diabetes, heart coronary attacks, cancers, etc.) and chronic fatigue syndrome (sleeping apnea, inefficient brain oxygenation). All these overweight-related comorbidities potentially limit the worker's attendance and concentration. In other words, overweight-based productivity loss theoretically leads to wage penalties. Even if the

overweight-related productivity loss may decrease across time and space, through the mechanization of manual and heavy tasks, the productivity effect remains negative because the risk of diseases and comorbidities is significantly higher for overweight workers than for normal-weight workers. However, note that productivity loss depends on employment status. For example, there is no doubt that the obesity-related productivity loss is higher in manual and physical jobs than in non-manual jobs insofar as physical ability is a prerequisite and an important wage determinant in manual activities, even after the mechanization of several physical tasks (Caliendo & Gehrsitz, 2016).

Compared to weight-related productivity loss, which is always negative, the effect of weight-related discrimination on wages is subject to perpetual changes in line with social and economic development (Poulain, 2017). Indeed, the effect of weight stigma on labor market outcomes is ambiguous, since it depends on the system of values in place at a given time and the level of development in the country concerned. In societies in which obesity is a major health problem and hunger has completely disappeared, as is the case in Western countries, excess weight is generally the subject of discrimination and is penalized at work. Recall the negative relationship between bodyweight and wages we discussed in the introduction (if we omit recent findings in England and Germany). Reversely, in sociocultural environments where hunger continues to prevail, as is the case in the poorest and traditional societies, excess weight is well perceived and rewarded. In other words, concerning the most vulnerable populations, the preference for overweight more than offsets the productivity loss induced by this nutritional status. The anthropological literature mentions the persistence of *past pro-fat* social norms in these countries (Brewis et al., 2018). Hence, one can assume that the positive appreciation of obesity (which characterizes or characterized developing countries) may disappear in the long run, given the worldwide convergence of beauty standards (Brewis, Wutich, Falletta-Cowden, & Rodriguez-Soto, 2011). Under this hypothesis, the relationship

between bodyweight and labor market outcomes would gradually change from positive to negative during the process of sociocultural homogenization. This changing trend explains why the relationship between weight and wages is unclear and probably nonlinear in middle-income countries (Shimokawa, 2008; Levasseur, 2019b). In this intermediate development stage, several anthropological studies suggest the co-occurrence of *pro-fat* and *anti-fat* social norms (Brewis et al., 2018). While *pro-fat* norms due to past -or current- nutritional deprivations may persist, the globalization process results in a diffusion of *anti-fat* norms in the developing world.

Besides being heterogeneous at the macroeconomic level, the relationship between bodyweight and wages also depends on within-country heterogeneity. According to Bourdieu (1986), each socio-professional category is influenced by a specific class culture (related to consumption habits, tastes and lifestyles). Therefore, one can assume that each socio-professional group is associated with specific weight preferences. For instance, several authors show that socially demanding jobs such as service and high-skill positions are particularly sensitive to thinness standards in the prevailing context in the US (Caliendo & Gehrsitz, 2016; Slade, 2017). Hence, non-manual workers may be particularly likely to incarnate *anti-fat* social norms. By contrast, in physically demanding activities (particularly in agriculture), overweight and moderate obesity are often considered as signs of muscular strength given the persistence of *pro-fat* social norms from traditional beliefs (Guendelman et al., 2011; Slade, 2017). For example, in the US, several authors found a positive effect of bodyweight on wages for male manual workers, especially in the African-American community. Furthermore, some demographic characteristics are strongly correlated with fat-related social norms. Indeed, women are more likely to be exposed to weight discrimination (and self-discrimination) compared to men, since their physical appearance is highly valued by employers, colleagues and clients (Huang et al., 2016; Slade, 2017). What is more, ageing

might be negatively correlated with the adoption of thinness ideals. In Mexico, Mancilla-Díaz et al. (2012) noted increasing social pressure on female bodies, leading Mexican young women to match Western ideals of beauty. Therefore, it is important to test the potential presence of demographic and professional heterogeneity in the case of emerging countries like Mexico.

Conjointly, both reverse relationships may lead to a vicious cycle between poverty and obesity, making the correlation between socioeconomic status and bodyweight progressively more negative (or at least less positive) as the development process proceeds (Levasseur, 2019a). On the one hand, obesity reduces achievement capacities at school and work (via productivity loss and the diffusion of *anti-fat* social norms). This lack of opportunities then leads obese individuals to fall into or remain in poverty. On the other hand, poor people have obesity-related lifestyles and consumption, which increases the risk of becoming overweight. Nonetheless, the assumption of a vicious cycle between poverty and obesity needs to be nuanced. In recent decades, a growing number of works have highlighted the increasing social acceptance of excess weight in societies where overweight and obesity have become the physical norm, as is the case in the US, England, Germany and Mexico (Janssen et al., 2004; Prina & Royer, 2014; OECD, 2014; Robinson & Christiansen, 2014; Kropfhäüßer & Sunder, 2015; Barbieri, 2018). In addition, technological innovations may explain the recent overweight premiums observed in these societies. Indeed, new technologies and production methods potentially make obese workers more productive by reducing the proportion of physically demanding jobs in society (Philipson & Posner, 1999).

3. Empirical strategy

First, we conducted semiparametric analyses of cross-sectional data acquired during the three waves of the MxFLS survey (2002, 2005-06 and 2009-12). A semiparametric design

makes it possible to graphically estimate the relationship between weight and wages without the need for any assumption about its functional form. This procedure appears to be appropriate for identifying changes in the relationship between bodyweight and wages across time. Once we better understood the functional form of the relationship, we parametrically checked the significance of the suggested trends using an OLS estimator. In the parametric model, we also explored potential heterogeneous effects according to age group, education level and occupation status. In a second step, we implemented a DD design to establish (under certain assumptions) a causal inference in the relationship between weight and wages. More specifically, we wanted to assess the impact of being overweight or obese on hourly wages across time.

3.1. Data

The data used in this study come from MxFLS, the first panel survey with a representative sample of the Mexican population at national, rural-urban and regional levels. The Mexican Institute of Statistics defined the sampling directives. The survey covers a 10-year period with three distinct waves. The first wave was carried out in 2002 with 35,677 individuals surveyed in 8,440 households (living in 150 municipalities across 16 Mexican states). Given the longitudinal dimension of the survey, the second (2005-06) and the third (2009-12) waves are based on the initial sample from 2002. In both waves, the follow-up rate of the initial sample exceeded 90% at the household level. MxFLS data include detailed information on the sociodemographic characteristics of households and individuals. Detailed data about individual incomes were also collected in the survey. Moreover, anthropometric data on all household members were measured directly in the home by trained staff from the Mexican Institute of Public Health.

In this article, we use several measurements of individual bodyweight, such as the

body mass index (BMI), the waist-to-height ratio (WHtR) and related clinical classifications (i.e. central adiposity, overweight, and obesity). While the BMI is an indicator of general bodyweight (calculated by the weight in kg divided by the squared height in meter), the WHtR measures the abdominal fat accumulation (calculated by the waist in cm divided by the height in cm). The survey staff measured the exact waist circumference at navel level using a flexible tape (accuracy 1cm), height with a stadiometer (accuracy 0.5cm) and weight with a weighting machine (accuracy 1kg). The official thresholds for BMI-based overweight and obesity are 25kg/m² and 30kg/m², respectively. Although the WHtR still does not have official thresholds, epidemiological studies suggest attributing a WHtR higher than 0.5^{cm}/cm and 0.6^{cm}/cm to central overweight and central obesity, respectively (Ashwell, 2011). Obviously, we excluded extreme values. Hence, only adults with a WHtR comprised between 0.3^{cm}/cm and 0.8^{cm}/cm, or with a BMI comprised between 15kg/m² and 45kg/m², were included in the empirical analysis.

Our analysis focuses on adult salaried workers and wage earners aged from 18 to 65 years (excluding pregnant women), who represent approximately 45% of the working-age population in Mexico. As salaried workers are more likely to suffer from wage discrimination than self-employed individuals or employers, we excluded the two latter job categories from the analysis. Indeed, the sources of discrimination differ between work statuses. While employees with obesity are generally stigmatized by their employer and/or colleagues, self-employed workers and employers are more discriminated against by clients. We measured the hourly wage variable using the reported wage from the principal activity during a regular month and the reported number of working hours spent on the principal activity during a regular week (Hourly wage = $\frac{\text{monthly wage}}{\frac{\text{weekly working hours}}{7} \times 30,5}$). The hourly wage is expressed in Mexican pesos using the year 2002 and the Center Region as the baseline in order to neutralize inflation and price gaps between regions. Next, we excluded hourly wages below the 1st and above the 99th

percentile from the sample to exclude extreme values. Finally, the hourly wage variable was log-transformed. Hence, only individuals with a log-hourly income between 0.6 and 5.1 were analyzed (i.e. between 2 and 166 Mexican pesos per worked hour). In alternative estimates, we also used the reported monthly wage as outcome variable. Note that, contrary to monthly wages, hourly wages do not capture the productivity loss associated with absenteeism or forced part-time work. Thus, the productivity loss is assumed to be more visible using monthly wages.

Obviously, cross-sectional semi-parametric and OLS estimates are not concerned by attrition problems. Each wave is representative of the Mexican population. Concerning our DD design, sample representativeness is more debatable. However, by comparing individuals across time, such designs deal with invariant selection bias. Moreover, there is no significant association between current wages and the WHtR-based nonresponses (e.g. when an individual refuses to be anthropometrically measured). Thus, we can consider that the non-response probability is randomly distributed. This is good news because endogenous nonresponses could bias the estimates. For instance, if rich overweight people tend to refuse to be anthropometrically measured by the survey staff, we would overstate the negative effect of overweight on wages.

3.2. Semiparametric and parametric estimations

According to the health economics literature, a semiparametric partially linear estimator is a good way to explore the assumed nonlinear relationship between bodyweight and wages (Shimokawa, 2008; Caliendo & Gehrsitz, 2016; Barbieri, 2018). The less restrictive form of this semiparametric estimator allows the fitted value of individual WHtR on log-hourly wages to be clearly visualized in a plot without requiring prior assumptions on the functional form. This model is said to be partially linear (or semi-parametric) because the control variables

(X_{it}) are linearly (i.e. parametrically) regressed, whereas the coefficient of the WHtR (W_{it}) is estimated using a nonlinear (i.e. non-parametric) Gaussian kernel function.

For each survey period t (2002, 2005-06 and 2009-12), the partially linear model is based on the following estimator (Robinson, 1988):

$$\log Y_i - E(\log Y_i | W_i) = \beta [X_i - E(X_i, | W_i)] + \mu_i \quad [1]$$

The conditional means are nonlinearly estimated using univariate Gaussian Kernel regressions and coefficients β and ρ are linearly estimated using OLS. Finally, the function $F(W_{it})$ is obtained by graphing:

$$\left\{ \begin{array}{l} E(\log Y_{it} | W_{it}) - \widehat{W} E(X_{it} | W_{it}) \\ \text{against } W_{it} \end{array} \right. \quad [2]$$

where Y_i refers to the hourly wage of an individual i and W_i is his/her WHtR. In the exploratory analysis, the WHtR is preferred because of this indicator has many advantages compared to the over-used BMI (Burkhauser & Cawley, 2008).² Then, X_i refers to the control variables that structure the wage function. Several individual determinants of labor income are included as control variables: age, the square of the age (a proxy of experience), gender, marital status (living as a couple or not), years of schooling, cognitive skills score (measured using the mental test based on the matrices of Raven). Note that the cognitive skills score can be considered as a proxy of worker ability. It is commonly accepted in the labor economics literature that such variables reduce a significant part of unobserved heterogeneity in wage functions. In addition to previous productivity-related factors, we also incorporate in the wage function a variable counting the number of children in the household to identify how many budgetary constraints the worker has to deal with. Then, we add variables that control for area differences: the region (Southeast, Center, West Center, Northwest and Northeast) and the geodemographic area (rural area, small town, medium-sized city and big city). We also

control for a score of infrastructural development of the municipality given by the highest authority available in the municipality. This score ranges from 0 to 6 to represent a low to a high level of infrastructure. More specifically, we calculate this score by summing the presence (or absence) of public transport, health center, refuse collection service, sewage system, hydraulic system and paved roads in the municipality. Finally, we control for occupation status by distinguishing manual workers from non-manual workers accordingly with the existing literature (e.g. Slade, 2017). To reduce potential task heterogeneity within the group of non-manual workers, we distinguish non-manual service workers from non-manual highly-skilled workers. Based on the official Mexican classification of occupations, manual jobs concern employees from the primary and secondary sectors (i.e. technicians, agricultural and blue-collar employees, machine operators, production assistants). Service jobs refer to activities where workers are generally exposed to the public and where their appearance is important (i.e. entertainment workers, administrative assistants, salespeople, service workers, transport workers, street vendors, security workers, domestic workers). Highly-skilled workers include employees who have the highest positions in the Mexican labor market (*profesionistas* or occupations that require academic or engineering qualifications, education workers, senior public servants and directors in the public and private sectors, heads, coordinators and supervisors in the service sector, foremen). We are conscious that our occupation groups are not perfect and remain heterogeneous, especially the group of service workers that mixes active, sedentary, social and non-social activities. However, as we only have a limited information about employments and tasks (e.g. no information about the degree of activity or sociability), we pragmatically opted for this division of occupations. Although it could be useful to incorporate more information concerning the quality of employment and the occupation in the earning function, this practice is extremely controversial in the literature and can turn out to be counterproductive. Because

occupational variables are strongly correlated with income and bodyweight, the inclusion of such variables is likely to introduce - even more - endogeneity into the model and thus bias the estimates. Hence, under the guidance of labor economists, we do not include this type of regressor in the main analysis (Nordman & Roubaud, 2009). Nonetheless, we produced alternative estimations that include more information concerning employment specificities (type of contract, Mexican classification of occupations) in the earning function, but as the results were similar, we did not include them in this article.

To explore the occurrence of heterogeneous effects in the relationship between bodyweight and wages in Mexico, we systematically distinguish the sample of men from the sample of women. We assume that metabolic factors and labor market conditions differ strongly across gender. Moreover, from a descriptive perspective, in further semiparametric estimations, we also distinguish manual workers and services workers from highly skilled workers.

We parametrically check the significance of fitted trends from the semiparametric procedure using an OLS estimator. In this way, we test several specifications. First, we regress log-hourly wages on WHtR and other covariates using linear and quadratic specifications of the WHtR. Then, to investigate the potential heterogeneous effects according to age group, education level and occupational status, we introduce interaction terms in three additional specifications. We build the interaction terms by crossing WHtR and the following indicators: age group (under or over 25 years old), education level (more or less than 13 years of schooling) and occupational status (manual, service and highly skilled jobs). In all OLS estimations, all control variables are included.

Given the explanatory variables considered, our model specification mainly reflects the second type of pathway through which bodyweight and wages are linked, i.e. productivity

loss and weight discrimination. Note that worker productivity is partially controlled for, since the dependent variable is expressed in hours (thus controlling for absenteeism and part-time work) and important determinants of productivity (e.g. education, experience, cognitive skills) are included in the model as control variables. In other words, our estimates are going to particularly identify weight-based discrimination. Nonetheless, the results of semiparametric and parametric estimations are only informative and cannot be interpreted as causal effects. Hence, we use a more sophisticated procedure to estimate the impact of bodyweight indicators on hourly wages in Mexico.

3.3. Addressing endogeneity

To establish a causal link, the main methodological issue consists in coping with endogeneity that may bias the relationship between bodyweight indicators and wages. First, the focus on wage earners potentially leads to an endogenous sample selection bias. Indeed, several unobserved characteristics, such as soft skills, social networks and individual preferences, might simultaneously affect the probability of being a wage earner and individual bodyweight. Such an endogenous sample selection bias might understate the effects of productivity loss and discrimination on labor market outputs. Indeed, a substantial proportion of overweight individuals is likely to be out of the labor market and not earn wages. For example, being overweight may limit access to salaried jobs due to comorbidities and discrimination by employers. In addition, there are unobserved factors simultaneously correlated with individual bodyweight and the unexplained part of the wage variance that may bias classical estimations (e.g. physical and social abilities). Such omitted factors could overstate the negative effect of weight gain on wages if physical and social skills are negatively linked to weight, but positively linked to wages. Finally, the presence of reverse causality may also influence the relationship between bodyweight and wages. As discussed in

Section 2, weight might influence earnings but it is well known that income, and more generally socioeconomic status, determine weight.

To tackle endogeneity problems, the health economics literature often uses instrumental variables strategies (e.g. Cawley, 2004; Shimokawa, 2008). However, given the absence of conclusive instrumental variables in MxFLS that allow endogeneity problems concerning the sample to be satisfactorily corrected, in this study, we implement an alternative procedure inspired by the impact assessment literature. As a matter of fact, a significant proportion of endogeneity problems can be eliminated using a DD strategy. Here we consider excess weight status as a treatment variable. By comparing the outcome gaps between treated (excess weight) and untreated (thin) individuals over time, this estimator eliminates the pre-existing time-invariant heterogeneity between the two groups, including hazards due to omitted factors. In other words, this approach assumes that heterogeneity remains constant over time. In the relationship under study, this assumption is not considered too heavy insofar as social skills, networks and preferences are likely to remain relatively stable over time, at least over a short period. Hence, controlling for time-invariant heterogeneity that distinguish overweight and thin workers, our DD estimates only identify hourly wage variations within individuals because of assumed technological or social shocks, which occurred on the considered period. Mathematically, our DD design takes the following form:

$$Y_{it} = \beta_0 + \beta_1 Excessweight_i + \beta_2 Time_t + \beta_3 Excessweight_i * Time_t + \beta_4 X_{it} + \rho Municipality_{it} + \varepsilon_{it} \quad [3]$$

where Y_{it} is the log-hourly wage for an individual i at time t (2002, 2005-06 or 2009-12). The treatment variable is binary and does not vary on the considered period (i.e. permanent excess weight versus permanent thinness). The time variable takes three values for each survey round

(i.e. 1, 2 and 3 for 2002, 2005-06 and 2009-12, respectively). Note that, in addition to control for a comprehensive set of individual, household and area characteristics X (described earlier), we introduce municipality fixed effects. Regarding estimated parameters, β_0 refers to the log-hourly wage of thin individuals in baseline ($t=1$), β_1 is the wage gap between excess weight and thin individuals in baseline, β_2 is the wage gap between survey rounds for thin workers, and β_3 is the average effect of being excess weight on hourly wages controlled for individual time-invariant differences. β_4 refers to estimated parameters of control variables and ρ refers to estimated parameters for each municipality. ε_{it} is the residual term. We run Equation 3 using an OLS estimator. For each regression, we cluster standard errors at the municipality level. As previously, we investigate the presence of heterogeneous effects according to gender and occupation (manual, service and highly skilled workers) by running sample specific analyses. In this identification step, several clinical classification based on WHtR and BMI are tested (i.e. central adiposity cut-off, and overweight and obesity BMI cut-offs), as well as other labor market outcomes (i.e. reported monthly wages). Further, a placebo test using cognitive skills' score as outcome indicator is implemented.

Finally, to check for the robustness of DD estimates, an alternative DD model controlling for potential baseline differences (i.e. baseline selection bias) is run. In this alternative model, we compare the hourly wage evolution between permanently thin workers (control) and workers who were thin at baseline but became overweight across time (treatment). A kernel matching based on baseline observed characteristics insures the comparability between permanently thin workers and the group of workers who were thin at baseline but became overweight on the period. Specifically, the propensity scores are calculated from a Probit model estimating the probability of belonging to the treatment group at baseline. Then, the weights (used to run DD estimates) are derived from the propensity scores using a kernel epanechnikov function (see Leuven & Sianesi, 2018 for more details).

4. Results

4.1. Summary statistics

Table 1 lists the median hourly wage and the median WHtR by gender and occupation status for the 2002 and the 2009-12 surveys. Not surprisingly, men generally have higher wages than women. Moreover, the highest wages are observed in high skill jobs and the lowest wages in manual jobs. According to the median WHtR, Table 1 shows a notable weight gain between 2002 and 2012 (while height remains unchanged). This weight gain is especially marked in women: from $0.51^{\text{cm}}/\text{cm}$ in 2002 (just above the central overweight threshold) to $0.58^{\text{cm}}/\text{cm}$ in 2012 (near the central obesity threshold). Consequently, male and female median WHtR are similar in the last survey period, excluded for manual male employees who are relatively thinner ($0.55^{\text{cm}}/\text{cm}$). Histograms of the distribution of WHtR across gender is available in Figure A.1 of the Appendix. It clearly appears that most of male and female salaried workers are centrally overweight and obese in Mexico.

Please insert Table 1 here

4.2. The relationship between bodyweight and wages: semiparametric and parametric estimates

Based on equation [1], we run six semiparametric estimates to compare global trends across gender and time (2002, 2005-06 and 2009-12). We also run occupation-specific semiparametric estimates (manual, service and high-skill jobs) from a descriptive perspective. The parametric part of these estimates, i.e. the fitted coefficient from the regression of log-hourly wages on control variables, is shown in Table A.2 of the Appendix (only for the whole gender samples and the 2002 and 2009-12 survey waves). Depending on the model specification, the R-square values indicate that our specification of wage determinants (excluding WHtR) captures around 21-34% of hourly wage variations, which is relatively

high compared to the labor economics literature (Gong et al., 2004). Gender-, time- and occupation-specific estimated values of log-hourly wage are nonparametrically plotted against WHtR in Figure 1, as announced in equation [2]. We match time-specific nonparametric estimates in the same plot to highlight changes in the WHtR-wage relationship across time. In each plot, to avoid erroneous interpretations, we only show nonparametric estimates from $0.4^{\text{cm}}/\text{cm}$ to $0.65^{\text{cm}}/\text{cm}$. Indeed, the number of observations is occasionally low beyond these values (see Table A.3 in the Appendix). Finally, we regress log-hourly wages on WHtR and other covariates using OLS estimators in order to check the significance of semiparametric estimates. These OLS estimates, listed in the Appendix in Table A.4 for women and in Table A.5 for men, test linear and quadratic specifications as well as the influence of several interaction terms. As previously, reported R-squares are relatively high, showing the model specification has strong explanatory power.

Please insert Figure 1 here

In the whole sample of female employees, Figure 1 denotes an expected change in the WHtR-wage relationship over the study period. Indeed, the trend shifts from a U-inverted shape in 2002, with the highest fitted hourly wages around central overweight (significant turning point at $0.56^{\text{cm}}/\text{cm}$, Table A.4 column 2), to a more negative shape in 2012, at least until a WHtR of $0.6^{\text{cm}}/\text{cm}$. Therefore, as suggested by the literature, a vicious cycle of poverty and obesity might be occurring in Mexico (Levasseur, 2019a). Interestingly, changes in the WHtR-wage relationship are different for Mexican men. Among men, Figure 1 shows a slight flattening of the positive relationship between WHtR and hourly wages across time. Table A.5 supports this trend since the association appears to be positively significant in 2002 (at the 10% level) but non-significant in 2005-06 and 2009-12 (columns 1, 7 and 13). As the slope decreased substantially over the period (between 2002 and 2012), one could expect a shift from a positive shape to a U-inverted (or eventually a negative) shape in the coming years.

Note that the negative trend observed in 2012 for women is especially strong for service workers (Figure 1). According to Table A.4 column 17, in 2009-12, an extra WHtR unit decreases the hourly wage of female service workers by 8.5% ($[-1.284+0.439]*10$) compared to manual and highly-skilled service workers (significant at the 1% level). The same trend occurs for service male workers in 2005-06 and 2009-12, although the magnitude is lower than for women. For male service workers, an extra WHtR unit is associated with a 4.8% decrease in hourly wages in 2005-06 and with a 2.3% decrease in 2009-12 (Table A.5 columns 11 and 17 respectively). This result is consistent with the literature. As assumed, this shift between 2002 and 2012 announces the potential diffusion of *new anti-fat* social norms in jobs where the physical appearance is highly valued by employers, colleagues and clients. Moreover, individual categories that are more subject to thinness ideals, such as young women, suffer from higher wage penalties. For young female workers (less than 25 yo), one extra unit of WHtR reduces the hourly wage by 5.9% compared to older female workers (Table A.4 column 15).

Interestingly, Figure 1 and Table A.4 column 14 illustrate the presence of a turning point at $0.61^{\text{cm}}/\text{cm}$ in the 2012 female sample, showing that there is a small group of obese women who earn higher wages. Table A.4 column 18 supports this result. Indeed, *ceteris paribus*, in 2012, an extra WHtR unit increases the hourly wage of highly-skilled female workers by 5.5% compared to service and manual workers (significant at the 5% level). Results are even higher for highly-skilled male workers, with a 19.7% increase in 2005-06 and a 7.9% increase in 2009-12 when WHtR rises by one unit compared to manual and service workers (Table A.5 columns 12 and 18 respectively). Similarly, an extra WHtR unit is associated with better hourly wages for highly educated workers (i.e. with more than 13 years of schooling) compared to less educated workers (i.e. 9.2% and 3.6% increases for men and women, respectively, results not shown). These findings echo the existing literature that

identifies a positive effect of belonging to the highest social class on the risks associated with central adiposity, because of screening jobs, stressful lifestyles, a lack of free time and risky-food consumption patterns (Levasseur, 2015). Another possible explanation for this new surprising positive trend might be recent social acceptance of larger body sizes given the dramatic increase in rates of overweight, obesity and severe obesity among high-skill employments in Mexico (see Table A.3 in the Appendix). Table A.3 in the Appendix shows that the proportion of central overweight and obesity reached respectively 86% and 78% among male and female highly-skilled employees in 2009-12. In addition, technological changes between 2002 and 2012 could also explain this new excess weight premium in high skill jobs.

Concerning manual work, we detect no significant shifts between 2002 and 2012 (Tables A3 and A4 in the Appendix). Despite several oscillations, the slope between WHtR and hourly wages remains slightly positive for men (except in the 2005-06 survey) and relatively flat for women (Figure 1). This lack of a shift is consistent with our intuitions: social change is likely to take longer for manual workers due to more traditional lifestyles. Nonetheless, the results for manual female workers need to be interpreted with caution given the limited number of observations and the high wage variance in this sample.

4.3. A bit of causality: difference-in-differences estimates

To identify recent changes related to the impacts of central overweight on hourly wages, we first implemented a procedure based on two differences: a treatment difference (being permanently classified as excess weight versus being permanently thin) and time differences (2009-12 and 2005-06 versus 2002). In other words, we identified the wage gaps induced by overweight status across time. To be able to infer causal impacts, DD estimates must satisfy one condition: changes over time in bodyweight status should not be correlated

with time-varying omitted factors that affect wages. Since we controlled our DD estimates for several individual, household and area characteristics, in addition to introducing municipality fixed effects, this assumption is relatively reasonable.

Please insert Table 2 here

Based on Equation 3, Table 2 shows the average impact of several measurements of excess weight (i.e. central adiposity, overweight and obesity) on hourly wage. Correcting for time-invariant heterogeneity between individuals, we only found a significant wage gap comparing obese workers and non-obese workers in the whole sample, which occurred between 2002 and 2005-06 (-15.3%). Surprisingly, this excess weight penalty is overall significant for men on this period, with respective wage gaps of -16.7% and 20.3% for overweight and obese male workers. Alternative estimates based on another DD design (i.e. kernel matching DD estimates available in Table A.6 of the Appendix) and another outcome (i.e. monthly wage in Table A.7 of the Appendix) reveal similar findings. In Table A.6, once controlled for baseline observed characteristics (as confirmed by balances tests shown in Table A.8 of the Appendix), becoming overweight between 2002 and 2005-06 decreases by 18.9% the average hourly wage of Mexican workers compared to workers who remained thin over the period concerned, especially for men (-19.3%). According to Table A.8 in the Appendix for example, on average, an overweight worker earns 14.1% less per month than a thinner counterfactual. Table A.7 also shows a placebo test using cognitive skills' score as outcome indicator. The fact that bodyweight status is not correlated with cognitive skills, once controlling for time-invariant heterogeneity and other covariates, suggests that our model is robust to potential time-varying heterogeneity, such as the acquisition of soft-skills across time by individuals.

Please insert Table 3 here

We also explored the potential presence of heterogeneous effects according to occupation, by running occupation-specific estimations. Table 3 shows strong wage penalties for service workers being excess weight compared to thinner counterfactuals (e.g. up to -32.8% between 2002 and 2005-06 when comparing central adipose workers to their normal waist counterparts). As mentioned earlier, the wage penalties we observed for service workers are consistent with the literature. Consequently, we can speculate that the observed effect for service worker is the result of wide diffusion of *new anti-fat* social norms in Mexico. Concerning manual workers, no wage gap was found in Table 3, suggesting that overweight is not particularly penalized in this sector. In contrast, we observed a non-significant earning increase among overweight or centrally adipose highly-skilled workers across time (around +30% between 2002 and 2005-06). This finding suggests that overweight highly-skilled workers are not suffering from the diffusion of *new anti-fat* social norms. For us, two phenomenon may explain this (non-significant) excess weight premium in high-skill jobs: (i) the emergence of *pro-fat* social norms due to the normalization of overweight in such activities; (ii) technological changes improving the obese worker productivity. Further research need to highlight this issue.

5. Discussion

This study analyses the relationship between bodyweight indicators and hourly wages in Mexico. In the first step, we described how it has evolved across time using cross-sectional semiparametric and parametric estimates. Globally, this preliminary work shows that the bodyweight-wage relationship is becoming progressively more negative for female workers and less positive for male workers. This result is consistent with the literature that assumes a vicious cycle between poverty and obesity following the economic development process (Levasseur, 2019a). Note that this negative trend is especially strong for female service workers and young women. In contrast to this negative trend, these first results also suggest

higher risks of central adiposity for high social positions. In line with the existing literature, the highest positions may be associated with stress, lack of free time and hazardous food behaviors in Mexico, which potentially increase the risk of overweight (Levasseur, 2015).

In the second step, we addressed assumed endogeneity problems by implementing difference-in-differences approach, which is said robust to time-invariant heterogeneity. More specifically, we assessed the effects of being classified as excess weight on hourly wage gaps across time, by controlling for municipality fixed effects as well as individual, household and area characteristics. The results show a significant wage penalty for overweight wage earners between the two periods, especially in the service sector, which emphasizes the wide diffusion of *new anti-fat* social norms. These results are consistent with the US literature. Indeed, several authors found that wage penalties induced by overweight are the highest in socially demanding activities such as sales and service occupations (Caliendo & Gehrsitz, 2016; DeBeaumont, 2009; Slade, 2017). Surprisingly, compared to the exploratory analysis, DD estimates suggest stronger wage penalties related to overweight and obesity statuses among men on the 2002-2005-06 period. This counter-intuitive gendered effect may reflect recent social changes regarding weight perceptions in Mexico, which suggests a growing valorization of male thinness in the service sector. In contrast, one can assume that female thinness ideals diffused earlier in Mexico (i.e. before the 2000').

Generally, the US literature found an overweight premium for male blue-collar jobs, especially among African-American men (e.g. Caliendo & Gehrsitz, 2016; DeBeaumont, 2009; Slade, 2017). However, our identification strategy did not produce clear results concerning Mexican manual workers, probably because DD approach cannot capture time-invariant social norms such as the persistence of *past pro-fat* norms. Finally, we found a positive but non-significant effect of being overweight on hourly wages for highly-skilled workers, controlling for time-invariant heterogeneity. Notwithstanding the lack of

significance, this finding is consistent with the exploratory analysis. In addition to the potential introduction of obesity-friendly innovations in high-skill jobs (e.g. smartphones, tablets, teleworking), we assume an increasing social acceptance of excess weight in the highest positions on the Mexican labor market. In the literature, these *new pro-fat* social norms have been observed in labor markets where overweight is predominant, not only in the US and UK (Robinson & Christiansen, 2014; Barbieri, 2018), but also in Mexico (Prina & Royer, 2013) and Germany (Kropfhäuser & Sunder, 2015). This new acceptance of overweight in the labor market is relatively alarming and may accelerate the global increase of bodyweight in the coming years (Cohen et al., 2013). Therefore, these interrelated social and health issues have important implications for public policy. For instance, health-based prevention policies should particularly target high-skill jobs where *pro-fat* social norms may increase. Conversely, anti-discrimination laws should better protect overweight workers in service jobs where the fat stigma is stronger.

Limitations

The main limitation of this study was focusing on only one dimension of the Mexican labor market, i.e. wage earners. Other employment outcomes also need to be investigated. Moreover, the DD approach implies time fixed effects. Thus, this procedure only captures recent changes in overweight-based productivity loss and weight stigma. By construction, our DD estimates cannot identify the persistence of *pro-fat* social norms from traditional beliefs because these norms are, by definition, time-invariant. In addition, we assume that the period under study is too short to estimate all weight-related changes in labor market outcomes. For instance, in contrast to the service sector, changes in the perception of overweight may be slower -or occur at different times- in the manual and high-skill sectors. Similarly, a longer longitudinal survey would be useful to identify the gendered expression of fat-related social norms across time. More specifically, further research should better identify the respective

diffusions of “*past*” and “*new*” *pro-fat* social norms in the lowest and highest social positions in emerging countries where overweight is becoming the physical norm.

Conclusion

Changes in the bodyweight-wage relationship across time point to a transition in the Mexican system of values. Controlling for important determinants of worker productivity (education, experience, cognitive skills, etc.), this study provides additional insight into the recent dynamics controlling the relationship between bodyweight and wages in the context of emerging countries where obesity has become predominant. Furthermore, this study identifies the significant diffusion of *anti-fat* social norms in the Mexican labor market, at least for service wage earners. This result can probably be generalized to other middle-income economies that are undergoing an equivalent increase in overweight, such as Argentine, North African and Middle Eastern countries, or South Africa.

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ENDNOTES

¹ In the US, several authors found an overweight premium in blue-collar jobs, especially among African-American men (DeBeaumont, 2009; Caliendo & Gehrsitz, 2016; Slade, 2017).

² First, the WHtR is a better predictor of health-related problems because it captures the fat distribution around the vital organs (i.e. central or abdominal adiposity) better. In addition, the WHtR identifies overweight and obesity better than BMI insofar as the latter cannot distinguish fat from muscles and bones. By comparing the relationships between different anthropometric measures and labor market outcomes, Johansson, Böckerman, Kiiskinen, & Heliövaara (2009) showed that waist circumference is the highest predictor of wages. Table A.1 of the Appendix exhibits conditional means of BMI's categories according to WHtR's categories. It is worth noting that BMI highly understates central overweight. Respectively, 25% and 39% of male and female central overweight workers are classified by BMI as normal weight.