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Socioeconomic classification of the working-age Brazilian population: a joint latent class analysis using social class and asset-based perspectives

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ABSTRACT

This paper presents and applies a methodology of socioeconomic classification that integrates asset- and social class approaches. We employ data from the 2013 Brazilian National Household Survey and use latent class analysis to identify clusters and classify the working population. With regard to social class the Brazilian occupations are classified based on the European Socioeconomic Classification (ESeC) schema and an indicator of employment status. As for household wealth, we use the items related to household condition, ownership of durable goods and access to public services with the highest discriminatory power. We also make use of variables that account for the Brazilian spatial and socio-demographic heterogeneity. We found four clusters which we term Latent Socioeconomic Stratum (LSeS). When compared we found an ordered pattern from the best-off LSeS (1) to the worst-off (4) with respect to household wealth and ESeC classes. Nevertheless, although the class composition of each LSeS reveals a distinct concentration of specific ESeC classes, all classes are present in each LSeS. Controlling for social class, differences in household wealth are more marked between LSeS than between social classes within the same LSeS. Hence, the methodology unveils the latent socioeconomic strata, reveals a class schema for each stratum and points out potential stratum fractions within them. The results were validated using variables external to the model, namely household food security status and years of schooling. The external validation revealed the same ordered pattern and the presence of stratum fractions.

Key words: socioeconomic classification; social class; asset-based approach; latent class analysis; Brazil

1. Introduction

The social stratification of a given population into groups with distinct levels of income, wealth, prestige, and power characterizes human societies across time. Such inequality results from specific socialization processes within social settings and institutions in which certain tangible and intangible assets and resources are more valued than others, and from their differential appropriation by individuals and groups according to social placement (Grusky 2001; Bourdieu 1987). Social placements tend to be associated with "reward packages" of unequal value according to the combination of economic, political, social, cultural, honorific, civil, and human capital they encompass (Grusky 2001). Therefore, social stratification refers to the multidimensional, latent and dynamic arrangement of society that stems from the uneven distribution and appropriation of such types of capital between strata. These differences tend to influence chances, performances and outcomes in domains such as demography (Bollen et al. 2001; Schneider and Hastings 2015), health research (House et al. 1994; Braveman et al. 2005), education

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(Bukodi and Goldthorpe 2013), labor market (Lucchini and Schizzerotto 2010) and social mobility (Erikson and Goldthorpe 2010; Breen and Jonsson 2005).

Different methodologies have been developed to identify the social and economic positioning of individuals and households. Socioeconomic status (SES) indicators based on education and income or indices coupling these elements with occupational prestige have long been used to classify individuals, families and other units of analysis (Cirino et al. 2002; Hauser and Warren 1997). SES has been the staple classification tool in American studies. However, educational attainment and income indicators are unable to embody individual social standing or aggregate wealth appropriately, especially in low- and middle income countries (Galobardes et al. 2006; Kamakura and Mazzon 2013). The method of choice in this regard has been asset-based indices, notably the wealth index, and particularly in demographic and health research in developing countries (Smits and Steendijk 2015). The wealth index classifies households according to variables that indicate housing conditions, ownership of durable goods, and access to public services. According to Rutstein and Johnson (2004), the household items and characteristics "are associated with the unit's relative position in the distribution of the underlying, unobserved wealth" (p. 4). Consequently, the criteria for item selection are pivotal to the consistency of the index.

A third methodology of social classification, which prevails in European studies, is the categorical classification of occupations as originally proposed by Erikson, Goldthorpe and Portocarero (1979) known as EGP schema. Its premise is that occupations encompass both labor market situations and work situations, which can also be distinguished from qualification, work monitoring, earnings, professional prospects, life opportunities, and thus social class (Erikson and Goldthorpe 1992). The class schema developed by Erikson and Goldthorpe is the backbone of the harmonized European Socioeconomic Classification (ESeC) devised for comparative class analyses between the European Union state members (Rose et al. 2010).

Our objective is to combine social class with an asset-based measure to classify the 2013 Brazilian working-age population. The aim is to simultaneously account for the social standing embedded and manifested in the individual's occupation and also household wealth level. The former indicates the individual's class position and reveals the individual and family social standing (Goldthorpe 2000). The latter reflects the long-term living standard common to all household members (Filmer and Pritchett 2001). Our methodology is therefore a socioeconomic classification of individuals comprising economic rank and social class. This combination allows us to account for both the influence of aggregate household economic reward and individual social placement.

However, neither the asset-approach nor class analysis can be routinely applied to underdeveloped and developing countries. Asset indices may include valued items, but their importance and weight are likely to differ from one country to another and also over time (Ichoku 2011). While a social class schema is appropriate for countries where the majority of the working population have a contractual employment relationship, it may not be suitable for countries like Brazil with constrained labor markets and a significant share of informal, unprotected workers. Finally, the asset-approach and class schema do not take family type and life cycle position, gender relations, and spatial heterogeneity

into consideration. These socio-demographic factors influence a person's potential occupation as well as the household needs and the ability to meet them (Kamakura and Mazzon 2013).

We employ the 2013 Brazilian National Household Survey[1] and adapt the ESeC to the Brazilian Classification of Occupations (BCO).[2] The ESeC was developed and thoroughly validated for comparative studies and was therefore our chosen social schema (Rose et al. 2010). Unlike the EGP, ESeC and other EGP-based procedures in which the assumption is that occupations convey employment relations, we include a separate variable that accounts for what we term as *employment status*, i.e., whether the individual holds an occupation as employee, employer, self-employed, or unpaid worker, and, if an employee, whether in formal – either civil servant or privately contracted – or informal employment. As for household wealth, items with the highest discriminatory power in the 2013 Brazilian context were selected and assessed. We account for socio-demographic and regional heterogeneity by adding these indicators to the model.

We use an extended latent class model in order to identify the classes that we term as latent socioeconomic strata (LSeS) and to classify the individuals. Latent class analysis is a probabilistic clustering technique that allows for multidimensionality and the identification of the strata that emerge from the information contained in the data, thus avoiding ad hoc classification criteria and a priori definitions (Kamakura and Mazzon 2013).

The next section provides an overview of the literature on wealth measurement and class schema, departing from the concept of socioeconomic status. The section ends with the conceptual framework that integrates both approaches. Section 3 describes the sample data, the operationalization of indicators into variables and concludes with the statistical method: the latent class analysis and its properties. The results are presented in Section 4 where we also examine each LSeS and analyze differences between LSeS and within LSeS. In Section 5 we verify the empirical consistency of the construct using two external variables: food security status and years of schooling. This study concludes with a discussion of the findings in light of our objectives and the literature.

2. Literature review

This research classifies individuals into socioeconomic strata using household wealth, social class as groups of occupations sharing common features, and socio-demographic indicators. Therefore, we discard the main elements of SES, namely educational attainment and individual income altogether. On one hand, this is because education and earnings are to a great extent embedded in the person's occupation. On the other hand, the use of education and the measurement of current income have methodological issues that tend to be more prominent in low- and middle-income settings.

Educational attainment does not capture educational quality, on-the-job training, and other investments in the professional career which may differentiate individuals with the same educational level (Kamakura and Mazzon 2013; Braveman et al. 2005). Indeed, the significance and implications of educational level tend to differ according to birth cohorts as well as for women and minorities

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[1] Available at http://www.ibge.gov.br/home/estatistica/populacao/trabalhoerendimento/pnad2013/.
[2] Available at http://www.mtecbo.gov.br/cbosite/pages/home.jsf.

(Galobardes et al. 2006). Similarly, current income carries a number of limitations such as large variations over time and misreporting (Howe et al. 2009). While temporary jobs and informal occupations are associated to misreporting due to memory error, income stemming from capital investment tends to be underreported (Keister 2014). Labor income is prone to marked variations in line with economic swings and it may be a weak indicator as a current measure of purchasing power, wealth and wellbeing depending on the individual's or family's stage in the life cycle (Howe et al. 2008). This is especially relevant for retirees inasmuch as current income does not necessarily reflect the actual availability of resources accumulated over life (Duncan et al. 2002; Kamakura and Mazzon 2013).

Permanent income (Friedman 1957) is therefore conceived as a better proxy of wealth (Howe et al. 2009; Bollen et al. 2001). Indeed, Friedman (1957) made a crucial distinction between current income and permanent income in which the latter reflects the effect of what the family unit considers as determinants of its wealth or set of assets. As a result, permanent income tends to be more strongly associated with consumption than current income as the latter does not capture savings and loans (Friedman 1957). Consequently, wealth may differ sharply across different social groups with comparable income (Braveman et al. 2005).

As permanent income is not amenable to empirical measurement, information on consumption expenditures has been used as its surrogate (Rutstein and Johnson 2004). Nevertheless, data gathering on expenditure requires appropriately-designed questionnaires, trained interviewers and lengthy collection periods (Howe et al. 2008). Non-monetary income may be an important constituent of the households' total income in low- and middle-income countries (Ichoku 2011) and expenditure information gathered in these settings may not be fully reliable (Howe et al. 2008; Rutstein and Johnson 2004). As a result, expenditure data is rarely available in these countries (Vyas and Kumaranayake 2006).

The asset approach has been used as an alternative methodology to circumvent the caveats of current income and the scarcity of expenditure data. According to Vyas and Kumaranayake (2006), wealth measures derived from household assets "have an advantage as compared to those based on income and consumption expenditure because they are not subject to problems related to recall bias, seasonality, and data collection cost and time" (p. 466).

2.1. The asset-based approach

Asset indices classify the socioeconomic standing by means of a measure of wealth employing households' assets and characteristics as well as access to public services. Asset indices are usually estimated through data from the Demographic and Health Surveys (DHS) and UNICEF's Multiple Indicator Cluster Survey (MICS) and they have been widely used in studies about education, demographic and health outcomes (Booysen et al. 2008; Howe et al. 2008; Bollen et al. 2001; Balen et al. 2010).

Based on the work of Filmer and Pritchett (2001), the asset-based approach constitutes an alternative to the challenge of generating a relatively stable measure of household wealth in the long-run in the absence of consumption expenditure data. The authors estimated the asset index using principal components analysis to obtain weights for consumer durables as well as conditions and characteristics of the household. They analyzed the internal consistency of the index and compared its performance to that

of consumption expenditures to predict school enrolment of children in India, Nepal, Indonesia, and Pakistan. The authors concluded that principal component analysis is a sound method to estimate weights and that the asset index performs as well as consumption expenditure in predicting school enrolment and it therefore constitutes a fair proxy for household living standard.

Howe et al. (2009) reviewed the literature and analyzed how far wealth indices based on DHS data function as an efficient proxy for consumption expenditure and found little evidence that wealth indices perform well "in the strict economic sense of the term" (p. 875). But what concerned them most was that the variables employed to estimate wealth indices were chosen on the basis of availability and consequently they tend to be "non-context-specific items" (p. 875). Since the indicators included in the DHS core questionnaire are standardized and limited, differences in socioeconomic positioning between countries and within countries may not be captured. Another potential issue with asset indices is related to the sole use of the first component's scores as weights for each item. It may account for a relatively small proportion of the variance and disregard potentially important information (Vyas and Kumaranayake 2006).

More recently, Smits and Steendijk (2015) undertook the challenging task of creating the International Wealth Index, a comparable measure for household material wellbeing "[…] that can be used for all low and middle income countries" (p. 65). The authors found wealth indices to be highly correlated with a number of welfare and poverty measures and thus to be appropriate to gauge socioeconomic stratification.

Limitations in the number and variation of asset items are the cause of other potential problems, namely clumping and truncation. Clumping refers to the clotting of households in a given point of the scale while truncation is related to the inability to discriminate the extremes of the distribution due to the absence of items (McKenzie 2005). Smits and Steendijk (2015) hold that the number of possible combinations out of eight binary items and four three-category items that they used efficiently prevent clumping while "[…] choosing the included assets strategically, […] allows for enough differentiation at the top and bottom end of the scale to prevent excessive truncation" (p. 68).

In brief, the asset index is an aggregate indicator at the household level, the data required for its computation are often available for low- and middle-income countries, and it is more reliable than the alternative indicators. For the purposes of this research, the item selection is based on the rationale of the asset by considering the items' discriminatory power and thus their value in contemporary Brazil.

2.2. Labor occupation and social class

Social class theory has its roots in two founding sociologists, Karl Marx and Max Weber. Marx was not pursuing a class theory in itself, but sought to distinguish the essential classes stemming from the conflicting productive relations, the bourgeoisie and the proletariat (Blau 1977). Weber, on the other hand, developed a theoretical social class framework emphasizing the common economic interests, assets, and life opportunities found mainly in labor market conditions (Weber 1978). The class schema, i.e., the social classification based on type of employment and occupations as originally proposed by Erikson, Goldthorpe and Portocarero (1979) rests chiefly on Weber's work and is the prominent approach in European studies. These authors aimed to "[…] bring together occupations whose incumbents are

typically involved in broadly similar market and work situations" (p. 416). Subsequently, Erikson and Goldthorpe (1992) revised this conception emphasizing the employment relations embodied in occupations rather than the occupations per se. The rationale is that labor positions, and not the occupation held, are the constituents of class structure.

Theoretically grounded, their methodology establishes three positions with respect to employment status, namely employers, self-employed and employees (Erikson and Goldthorpe 1992). Employees, the bulk of the working population in developed countries, need an additional distinction inasmuch as their relationship with employers takes various forms. The theoretical rationale set forth is that different employment relations are implicit in the occupations because distinct employment contracts regulate the employee's performance.

The forms assumed by the work regulation are related to two issues that employers face to ensure that employees carry out their tasks: monitoring and specific assets such as job skills, work competence and personal qualifications (Rose and Harrison 2007). Different occupations imply different levels of monitoring and asset specificity. Occupations in which monitoring is not possible are at one end of the spectrum; these are mostly high-asset specific occupations. The occupations in which monitoring is feasible and put to use are at the other end of the spectrum; these are mostly manual occupations (Rose and Harrison 2007).

The type of employment contract known as service relation regulates the work in occupations with high asset specificity and that are more difficult to monitor (Rose et al. 2010). These contracts are used for jobs in which employers demand specific skills and need to delegate authority and monitoring tasks. The service relation implies more stable work positions, potential professional advancement and enhanced employability. Labor contracts regulate the work in occupations that do not demand high human assets and with few monitoring problems. Labor contracts tend to have a shorter duration, employees are supervised and the amount of work they supply is predetermined. Intermediate employment relations are between the two and combine features of service relation and labor contract, and are found notably in clerical, sales and service occupations (Rose et al. 2010).

Varying employment relations embody distinct labor market and work situations for employees (Erikson and Goldthorpe 1992). A labor market situation is said to be directly related to the monitoring and asset specificity issues and hence to the type of contract, whether service relation or labor contract. The labor market situation reflects income source and magnitude, income and labor stability, chances of professional progression. Jointly, work and labor market situations engender objective opportunities, attitudes, and patterns of action (Goldthorpe 2000). The rationale is that the employment relations embodied in employment status and occupations define socially analogous contexts. Indeed, according to Chan and Goldthorpe "[…] it is supposed that individuals with similar employment status and occupation are likely to be subject to similar forms of employment relations and thus to have similar class positions" (2007, p. 513).

Occupations are divided into classes according to the type of employment contract and thus the mode of work regulation. With respect to employers, Erikson and Goldthorpe (1992) distinguish between large and small employers. The former delegate management tasks and these tend to be carried out by the

latter. Small employers are further classified as professionals and non-professionals. The differentiation between professionals and non-professionals is also applied to self-employed laborers.

In 1994, the United Kingdom's Office of National Statistics commissioned the Economic and Social Research Council to undertake the revision of its social classifications. Given its theoretical basis, broad scope, and empirical aim, an adaptation of the EGP schema was adopted as the country's official social classification (Pevalin and Rose 2002). Under the denomination of National Statistics Socio-Economic Classification (NS-SEC)[3], it included a fourth basic position for individuals involuntarily out of work (Pevalin and Rose 2002).

In 1999 the Statistical Office of the European Communities (Eurostat) began initiatives with the aim of developing methodological tools to analyze and enhance knowledge about "differences in social structures and socio-economic inequalities across the European Union" (Rose and Harrison 2007, p. 459). In its 2001 report, the Expert Group recommended "a common socio-economic classification for all EU member states based on the concept of employment relations" (Rose and Harrison 2007, p. 460). This gave rise to the European Socioeconomic Classification project, the objective of which was to harmonize the socioeconomic classifications of EU state members. The result was the harmonized European Socioeconomic Classification (ESeC). Rose and Harrison (2010) edited a book that presents and discusses the ESeC conceptually and operationally and examines its validity in analyses on education, unemployment, poverty, deprivation, and health issues.

2.3. Sociodemographic context

Brazil presents great regional and municipal heterogeneity in terms of population, resources, and public services. In 2013, 42 percent of the Brazilian population lived in the most developed region, the Southeast, and 27.7 percent in the poorest one, the Northeast. While 15.2 percent of the total population lived in rural areas, 48.6 percent of these were in the Northeast. On the other hand, 50 percent of the metropolitan dwellers resided in the Southeast. It should also be noted that, in 2010, the country's 5656 municipalities ranged in size from the smallest with eight hundred inhabitants to São Paulo with over eleven million.[4]

There are marked regional differences in employment status and occupations. In 2013, 3.8% of the working population were employers and 42.4% were protected employees; both categories prevailed in the Southeast region and to a lesser extent in the South. Indeed, 45.9% of the employers and 52.7% of the formal employees were in the Southeast. Moreover, 51.1% of the southeastern working population were formal employees while the figure for the South was 47.8%. Within the formal, protected employees category, 38.9% live in metropolitan areas; and 53.7% of all workers dwelling in metropolitan areas are protected employees. Last but not least, higher grade, administrative, service and medium-level technical occupations were concentrated in the Southeast region.

On the other hand, informal employees (19.1% of the national working population in 2013) and self-employed workers (20.7% of the total) were more likely to be in the Northeast region and to a lesser

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[3] Erikson and Goldthorpe (2002) considered this denomination "somewhat unfortunate" (p. 33).
[4] Available at http://www.sidra.ibge.gov.br/bda/popul/default.asp?z=t&o=25&i=P. Access on July 2016.

extent in the North. More specifically, 33.1% of the informal employees and 30% of the self-employed workers were in the Northeast in 2013. With respect to non-paid workers (6.5% of the working population), almost half (49.4%) were in the Northeast region. Overall, 84.7% of non-paid workers and 22.2% of the self-employed workers lived in rural areas. Moreover, 43.8% of rural occupations were in the northeast. In the North, 21.7% of all occupations were rural while the figure for the Northeast was 24.2%.

In sum, more qualified, protected occupations are more prevalent in the major urban areas of the Southeast and South regions, which are the most developed and wealthiest. Less qualified and unprotected occupations prevail in the Northeast and North regions; rural occupations, comprised chiefly of self-employed and, above all, non-paid workers, are in the majority in these regions.

Special mention should be made of public servants who made up 7.4 per cent of the country's working population in 2013 and 35.7 per cent of whom held higher grade occupations. In fact, 28.9 per cent of the population with higher grade occupations were public servants. Not only were public servants disproportionately represented in higher grade occupations but most of the public servants were located in metropolitan areas.

State and municipal governments are responsible for services such as water supply and waste collection; as a result, they are not homogenously distributed across the territory but are associated with the region and place of residence (Kamakura and Mazzon 2013). While households in metropolitan areas in the wealthiest region, the Southeast, are more likely to be supplied, rural areas in the poorest region, the Northeast, tend to lack basic services. Between these extremes, other combinations are found in small and large urban areas and the remaining regions – South, Center-west, and North.

The availability of resources may not be the main determinant for the ownership of a given asset. Individuals and families have different sets of alternatives regarding acquisitions and investments depending on a number of mediating circumstances and conditions. For example, a computer may be indispensable as a working tool in a better-off metropolitan household but of little use in a rural one. Moreover, the need and presence of certain items tend to vary according to the households' position in the life cycle. Family composition and time in the labor market differentiate the household's needs and their capacity to meet them (Kamakura and Mazzon 2013; Duncan et al. 2002). Consequently, assets may value and be valued differently in each unit and so tend to be asymmetrically distributed.

These factors can also influence the occupations taken over a person's life. First, some occupations are only available in certain metropolitan areas or in certain parts of the country. Secondly, occupations are related to labor experience and thus with age (Connelly et al. 2016). Lastly, sex is an important determinant of the type of occupation (Connelly et al. 2016; Wright 1989). Depending upon conditions such as age, marital status and family type, gender status may influence whether women work outside the household, their working hours and what occupation they may take. Moreover, gender inequality is highly associated with occupational segregation which places women in disadvantageous positions in the job market (Madalozzo 2010; Jarman et al. 2012).

In sum, these are socio-demographic factors that influence both occupation and household wealth and therefore are incorporated in the latent class model.

2.4. Conceptual framework

We assume that Adapted ESeC and household wealth define a set of profiles or underlying classes. The Adapted ESeC conveys the labor market situation and the work situation, clustering individuals who tend to share similar life backgrounds, conditions and opportunities (Rose and Harrison 2007). Adapted ESeC is an individual indicator and therefore a parcel of households may prove to be cross-class, i.e., with individuals of distinct classes (Erikson and Goldthorpe 1992). Household wealth is not only a measure of social positioning, but it also makes a common mark on individuals who live together. Our point is that shared assets and equal living conditions tend to bring the unit's dwellers together even if they have different Adapted ESeC. The socio-demographic contextual factors act synergistically with individuals' social class as well as with household wealth.

In light of this rationale, the conceptual model set forward in the study (Figure 1) assumes a discrete latent variable that we call Latent Socioeconomic Stratum (LSeS) that jointly summarizes the structural relation between the indicators in the three domains. This model can be seen as a Multiple Indicators and Multiple Causes (MIMIC) model as it adds covariates that explain the latent variable. Hence, *Labor occupation* and *Other profiling* variables explain the belongingness to each *Latent Socioeconomic Stratum (LSeS)* class conditionally to a given set of assets.

=== **Fig. 1**: Conceptual model ===

3. Data, indicators, and method

3.1. Data

The dataset employed in this analysis is the 2013 Brazilian National Household Survey (PNAD 2013). Its questionnaire is designed to systematically investigate the population's general characteristics, education, labor, income, and housing conditions. It includes a supplementary module that varies from year to year as its content is defined according to the need for specific information at the national level. In 2013 the supplement inquired about food security. The sample size allows for representativeness from the national level down to the level of metropolitan areas.

The 2013 survey's dataset has 361602 observations. Our subsample is the 279380 individuals aged fifteen years and older. Of these, 65.1 percent worked in the week or in the year of reference.

3.2. Indicators

3.2.1. Household service and asset indicators

The use of asset indices that are comparable between countries and over time is highly desirable. Comparability requires the construction of wealth indices using the same items and categories for every country and year (Smits and Steendijk 2015). However, social and economic changes in a given country may make some indicators undifferentiated while others may acquire high discriminatory power. For the

purposes of this study, the strategy is to select assets, access to public services, and household conditions that best manifest wealth in the 2013 Brazilian context.

As for the household characteristics, the number of bathrooms is a paramount indicator of economic wealth. Household ownership and number of dwellers per bedroom are not as discriminatory, but these indicators are important to distinguish the poorest households. In 2013, access to electricity was practically universal (99.6 percent of the households) as was television ownership (97 percent). Although 97.2 percent of the households had a refrigerator, differentiation between one-door and two-door appliances currently sets households apart. The landline telephone is less important than in the 1990s when there were almost no mobile phones, but the situation had reversed in 2013. By the same token, computer ownership and internet access is as valued nowadays as a television set was in the past. With respect to DVD player, washing machine, and car, the more expensive the item the greater its discriminatory power.

In Brazil, state and municipal governments are responsible for supplying the sewage system, water supply, and waste collection, and consequently these services are not homogeneously distributed across the country. The likelihood of access to basic sanitation in smaller cities, poorer rural areas or peripheral urban areas is substantially smaller than in wealthier, large, central metropolitan areas. Indeed, in 2013 65 percent of the households with no sanitation were in the Northeast region whilst 64 percent of the households with access to this service were in the Southeast region.

Our selected items comprise five two-category indicators, five three-category indicators, and three four-category indicators (see Table A1 in Appendix for wealth indicators, categories, and observed proportions). The number of total possible combinations is over 250000 and minimizes the chance of clumping.

3.2.2. Labor profiling indicators

As an instantiation of the EGP class schema, the ESeC classification starts by distinguishing between employers, self-employed, employees (Rose et al. 2010). Like the NS-SEC, it adds a fourth position: the unemployed. Employers are classified as large (ten or more employees) and small (less than ten employees) and as professionals or non-professionals. The professional and non-professional distinction also applies to the self-employed. Employees are classified according to their occupations. The ESeC schema has ten classes (Rose et al. 2010).

Methodologically, the crux of the Erikson and Goldthorpe (1992) class schema and therefore of the ESeC framework is that employment status and occupations convey specific employment relationships (Rose et al. 2010). Consequently, grouping employers by firm size, small employers and self-employed as professionals or non-professionals, and employees by occupation is equivalent to grouping individuals who share a similar employment status as well as work and labor market situations. Thus, the method is empirically a categorical classification as it requires sorting and aggregating a set of employment status positions and occupations according to the firm size, job requirements, level of autonomy, necessary skills and, in most cases, employees' type of contract.

Nevertheless, in Brazil the employment relations are not necessarily contained in the occupations because a substantial proportion of the working population is in the informal sector. In fact, 19 percent of

the Brazilian working population in 2013 was employees with no contract whatsoever, 20.5 percent were self-employed, and seven percent were unpaid workers.

Moreover, regulations applying to public servants and private workers differ greatly. Public servants are employed under what is termed a 'unified regime' which grants them job tenure as well as retirement pensions paid by the municipalities, states or federal government. Private employees contracted in conformity with the Brazilian Labor Legislation (BLL) are entitled to rights such as a thirteenth month's salary, paid vacations, social security coverage, and monetary indemnity in case of non-justified dismissal.

Among private employees, there is a cleavage between those contracted in compliance with the BLL and those who are not. As the latter are in informal employment, they are not subject to the national labor legislation, and therefore they are not entitled to legal employment benefits and their income is not taxed (International Labour Office 2003).

Professional self-employed workers have higher education attainment and income than non-professional self-employed workers. Indeed, the high proportion of non-professional self-employed workers and the endurance of informal labor agreements in Brazil are strongly associated with manual jobs which are occupied predominantly by semi- and unskilled, low-educated social groups. In 2013, 45 percent of informal employees were domestic workers, care workers, sale assistants, construction workers and workers in the agricultural sector with an average of 5.6 schooling years as compared to 7.3 for this category as a whole. Sales assistants, agricultural producers, and construction workers comprised 41.1 percent of the self-employed laborers. The average years of schooling in these occupations was 6.1 as opposed to 7.1 for all self-employed workers.

Some occupations may have either a formal or an informal arrangement and thus the employment relationship can take different forms. Domestic work, for instance, may be subject to three different contractual possibilities, namely, BLL employee, informal employee or daily laborer. The challenge is to capture the different types of employment arrangements for the same occupation.

The survey questionnaire includes variables for employment status – employer, employee, self-employed laborer, and unpaid worker – and for occupation. In the case of employees, it collects information on whether the respondent holds a public or a private position, and, if in the private sector, whether he or she holds a signed labor card or not. Instead of assuming that the employment relationship is embedded in the occupation, we created an employment status variable that differentiates public from private workers and, for the latter, those with a BLL contract from those without. Hence, this variable indicates employment status, namely employer, formal employee, informal employee, self-employed laborer or unpaid workers. It further distinguishes the public servant and private employee categories of formal employees (Table 1).

=== Table 1 about here ===

As for occupations, we adapted the Brazilian Occupational Classification that the national office of statistics[5] employs in its household surveys to the ESeC class schema (Table 2). With respect to the

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[5] Instituto Brasileiro de Geografia e Estatística (IBGE), http://www.ibge.gov.br/home/.

Adapted ESeC 1, we kept the cutoff value of five employees used by IBGE to distinguish small and large employers. The Adapted ESeC 2 comprises lower professionals and higher technicians in the Brazilian classification. Adapted ESeCs 3 and 7 distinguish middle and lower non-manual occupations in the service and sales sectors. ESeCs 4 (small employers and self-employed in nonprofessional occupations excluding agriculture) and 5 (self-employed and small employers in agriculture, fisheries and forestry) were not used because the joint use of employment status and adapted ESeC make these classes redundant. ESeC 6, made up of higher grade blue collar occupations (basically lower supervisory and lower technician occupations), and 8, formed by skilled workers in lower blue collar occupations, were collapsed in the Adapted ESeC 5 because ESeC 6 represents less than two percent of the workers in industrial production, repair, and maintenance occupations. Adapted ESeC 9 consists of semi- and unskilled occupations like ESeC 9, but with a high proportion of informal workers in the service sector. Finally, we created the Adapted ESeC 7 consisting of rural occupations since the combined information of Adapted ESeC and employment status allows make it possible to detect the employment status of those engaged in rural activities.

=== Table 2 about here ===

In the case of unemployment or non-work in the week of reference, we employed both employment status and adapted ESeC of the last job during the year of reference (Table A2 in the Appendix). In this manner, we adapted the ESeC and established the employment status for 65.3 percent of the 279380 working-age individuals. Retirees who were responsible for the household were kept in the analysis (7.4 percent of the total).

3.2.3. Socio-demographic profiling indicators

The socio-demographic indicators included in our model are region and place of residence – metropolitan areas, large and small urban areas, and rural areas. These are country-specific indicators and account for Brazil's spatial heterogeneity. We add sex and age due to their influence on the position in the labor market. Family type is an indicator for the position in the life cycle. While age is an individual variable, family type applies to all members of the household. We assume that household indicators act upon all its members equally. A detailed description is given in Table A2 of the Appendix.

3.3. Method

Some concepts in social sciences such as class cannot be directly observed. Nevertheless, non-observable, i.e., latent variables, may manifest themselves through observable and measurable indicators. If the manifest variables are good indicators for the latent variable, then the covariance pattern between them should conform to the latent variable model. In this case the latent variable is taken as the true source of the observed indicators (McCutcheon 1987).

Latent class models assume that the interrelation between categorical variables is explained by an underlying categorical latent variable, the latent class (Lazarsfeld and Henry 1968; Goodman 1974;

Bartholomew and Knott 1999; Collins and Lanza 2010). This technique has been applied in many fields with distinct purposes (McLachlan and Peel 2000; Hagenaars and McCutcheon 2002). One of the main applications of latent class models has been in the identification of clusters or subpopulations in a given population (McLachlan and Basford 1988). In this regard, it can be seen as a probabilistic or model-based clustering technique: each observation belongs to a given latent class and, conditional on the given latent class, we expect a specific pattern of the categorical observed data. In this work we apply an extended latent class model that combines two different types of observed variables: the manifest/indicator variables used in the definition of the latent class and a set of variables used in the profiling of the latent classes.

Let respondent i be characterized by $\boldsymbol{x}_i = (x_{i1}, \ldots, x_{iJ})$ and $\boldsymbol{w}_i = (w_{i1}, \ldots, w_{iL})$, the vectors containing the sets of J items and L profiling variables, respectively. Then, the latent class model with S latent classes is given by

$$f(\boldsymbol{y}_i; \boldsymbol{\varphi}, \boldsymbol{w}_i) = \sum_{s=1}^{S} \pi_{is}(\boldsymbol{w}_i, \boldsymbol{\gamma}_s) f_s(\boldsymbol{y}_i; \boldsymbol{\theta}_s)$$

where vector $\boldsymbol{\varphi}$ contains all parameters in the model and z_i is the latent class assuming S distinct categories with $P(Z_i = s) = \pi_{is}(\boldsymbol{w}_i, \boldsymbol{\gamma}_s)$, which define the prior probabilities as logit function of the profiling variable $\boldsymbol{w}_i$. The conditional distribution $f_s(\boldsymbol{y}_i; \boldsymbol{\theta}_s)$ gives the expected observed values of the manifest variables in latent class s and $\boldsymbol{\theta}_s$ characterizes each latent class in terms of the items $\boldsymbol{y}_i$ used to measure the latent class. Typically, it takes the form of a product of independent multinomial distributions within each latent class. The maximum likelihood estimation of this latent class model is not available in close-form, and the expectation-maximization algorithm (Dempster et al. 1977) is used to obtain the estimates. The optimal number of latent classes is traditionally given by information criteria. We apply the BIC – Bayesian Information Criterion (Schwarz 1978). We select the number of latent classes that minimizes $BIC_S = -2\ell_S(\boldsymbol{y}_i; \boldsymbol{\varphi}, \boldsymbol{w}_i) + N_S \log(n)$, where $\ell_S(\boldsymbol{y}_i; \boldsymbol{\varphi}, \boldsymbol{w}_i)$ is the log-likelihood function, N_S is the number of free parameters of the model, and n is the sample size. BIC selects parsimonious models that take the trade-off between model fit and model complexity into account.

4. Results

4.1. Selection of the optimal number of latent classes

First, to identify the number of latent classes, i.e., the latent socioeconomic strata (LSeS) that best describe the unobserved heterogeneity in the sample, we estimated the model with asset indicators, household characteristics, and access to basic services, i.e., the manifestation of the latent class variable (Collins and Lanza, 2010). The BIC recommends the use of four latent classes as the best partition to describe data heterogeneity.[6]

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[6] Latent class estimation varying the number of latent classes from one to 10 shows that in solutions with more than four latent classes, the extra latent classes can be ignored as they do not help extract unobserved heterogeneity from the large data set. Detailed results on model selection are available from the first author upon request.

In the second step, after identifying the number of latent classes, we estimated the full model which includes the profiling variables. Table A1 and A2 in appendix report the estimates for the indicators and profiling variables, respectively.

We obtained four latent socioeconomic strata (LSeS). LSeS 1 is the largest, followed by LSeS 3 and then by LSeS 2 and LSeS 4 with similar percentages. There were 590 domestic workers and their relatives living in the households. Since they have no family bond within the household they were not included in the analysis. Table 3 shows the overall distribution of LSeS.

=== Table 3 about here ===

4.2. Characterization of the latent socioeconomic strata (LSeS)

The characterization of the latent socioeconomic strata in terms of household characteristics and the observed proportions are given in Table A1 in the Appendix. LSeS 3 families are more likely to live in rented accommodations and probably with one bathroom. In fact, this is the only stratum in which house tenure is below the observed proportion for this category. On the other hand, the occupation of housing as a concession is most probably in LSeS 4. Otherwise, the proportions of families owning their house in the four LSeS are close to the observed proportion for this category (0.771).

LSeS 1 presents the highest probabilities of living in a house with two and especially three or more bathrooms, while LSeS 2 is more likely to have one bathroom. While LSeS 3 is characterized as having one bathroom, there is a sizable proportion of households in LSeS 4 have no bathroom as compared to the observed proportion (0.029). It is worth highlighting that this variable organizes the LSeS into better-off to worse-off. Indeed, with respect to the number of dwellers per bedroom, LSeS 3 and LSeS 4 present significantly higher proportions of category '2 or more' than the observed for this category (0.163).

Almost all houses in LSeS 1 and LSeS 3 have piped water in the dwelling. LSeS 4 has the highest probability of no water supply and of water piped from a well. In comparison with LSeS 3, LSeS 2s houses are more likely to have water piped from a well and less likely to be serviced with piped water.

The observations on the water supply are to a great extent also applicable to sewage. LSeS 1 houses are substantially more likely to have a public sewage system than the other three strata. The probability of LSeS 2 and LSeS 4 houses being connected to the public sewage system is well below the observed proportion for this category (0.53). Indeed, LSeS 2 houses are more likely to have either a pit latrine or a septic well while LSeS 4 has almost no probability of public service. LSeS 3's distribution is quite similar to the overall distribution observed for this variable.

With respect to waste collection, LSeS 1 and LSeS 3 are more likely to have a public household collection service, although LSeS 3 has a relatively high probability of indirect collection. LSeS 2's distribution is quite similar to the overall distribution observed for this variable, but has a lower probability of public household collection than LSeS 1 and LSeS 3. The probability of no waste collection whatsoever is highest for LSeS 4. Table 4 summarizes the LSeS in terms of household characteristics and utilities.

=== Table 4 about here ===

The indicators about household characteristics and access to basic services place LSeS 1 in the best position and LSeS 4 in the worst position. LSeS 2 and LSeS 3 are in intermediate positions. LSeS 2 is better-off than LSeS 3 regarding home ownership, dwellers per bedroom, and number of bathrooms. LSeS 3 is ahead of LSeS 2 regarding water supply, sewage, waste collection. This difference is related to place and region of residence.

LSeS 2 have a relatively high probability of residing in rural and small urban areas in the North, Center-West, and South regions. LSeS 3 is characterized by a higher probability of residing in small and large urban areas mainly in the Northeast region. State and municipal governments tend to concentrate the service provision in metropolitan and large urban areas. Thus, it is not surprising that LSeS 3 outperforms LSeS 2 in the three indicators of public services, but lags behind the three that reflect household comfort and affluence. The same applies to LSeS 4, the most underprivileged, which is largely in rural areas of the North and Northeast regions, and LSeS 1, the best positioned, which is mainly in metropolitan areas and larger cities of the Southeast region.

In order to obtain a more accurate picture of household affluence we examined assets by LSeS as presented in Table 5.

=== Table 5 about here ===

The landline telephone does not differentiate any strata. Dwellers of LSeS 3 and chiefly of LSeS 4 accommodations are less likely to have a mobile phone compared to LSeS 1 and LSeS 2 . LSeS 3 and particularly LSeS 4 families are less likely to own a DVD player. LSeS 1 has the strongest probability of owning a two-door refrigerator. Refrigerator ownership does not differentiate LSeS 2, but the proportion of households with a two-door appliance is higher than the observed proportion for this category (last column of Table A1). LSeS 3 is more likely to have a one-door refrigerator and LSeS 4 has the highest probability of owning neither.

The majority of LSeS 1 households own a washing machine. Washing machine ownership does not differentiate LSeS 2 from the observed proportion for this category. LSeS 3 and LSeS 4 have a high probability of not owning a washing machine, 0.66 and 0.89 respectively. LSeS 1 is the most likely to own a computer with internet access. LSeS 2 has a relatively high probability of computer and internet access, but lags far behind LSeS 1. Again, there is a high probability of not owning a computer in LSeS 3 and LSeS 4, and particularly in the LSeS 4 stratum.

Finally, most LSeS 1 families own a car. The probability of having a car is lower in LSeS 2 than LSeS 1 but higher in LSeS 3 and LSeS 4. The LSeS 3 stratum is the most likely not to own either a car or a motorcycle, while the probability of owning a motorcycle is the highest in LSeS 4. These results also reveal that the LSeS can be ordered in terms of the set of household assets indicators, with LSeS 1 being the most likely to have the best categories for each indicator and LSeS 4 to have the worst. LSeS 2 is closer to LSeS 1 except for water supply, sewage, and waste collection, whilst LSeS 3 is situated between

LSeS 2 and LSeS 4. The only asset indicator in which this order does not prevail is the car or motorcycle ownership in that LSeS 4 is more likely than LSeS 3 to own one of them.

4.3. Adapted ESeC, employment status and latent socioeconomic strata

Next we examine the composition of each stratum by social, i.e., occupational, class through the Adapted ESeC.[7] As Table 6 indicates, the LSeSs are characterized by the predominance of more than one Adapted ESeC class. LSeS 1 is the most likely to have workers in the higher salariat, lower salariat and intermediate classes. Nevertheless, there is an important proportion of lower white-collar and blue collar/skilled workers. Only 27.3 percent of the workers in this stratum are in unprotected positions.

Occupationally, LSeS 2 is one level below LSeS 1 since intermediate, lower white-collar and blue-collar/skilled occupations predominate in this stratum. In fact, the LSeS 2 is the most likely of the four strata to have blue-collar/skilled workers. Unprotected work amounts to 41 percent of this class.

In LSeS 3, the occupational level is again lower. It is the most likely to have lower white-collar and semi-, unskilled occupations. There is also an important proportion of blue-collar positions and retirees who are responsible for the household. It should also be noted that ESeC 3 and ESeC 4 have the oldest age distributions of the four strata. As for employment status, 45.2 percent of individuals in ESeC 3 are in unprotected positions, which makes it less formal than ESeC 2. Agricultural occupations constitute the bulk of LSeS 4; this is by far the stratum with the most unprotected workers, male unpaid workers, self-employed laborers and unprotected employees.

=== Table 6 about here ===

In relation to the Adapted ESeC and employment status, the composition of each stratum points to the same ordering disclosed in the analysis of household assets and services, i.e, from the better-off (LSeS 1) to the most disadvantaged (LSeS 4). LSeS 2 and LSeS 3 are intermediate strata.

It is important to highlight that all the adapted ESeC classes enter the composition of each LSeS to some extent. The class heterogeneity encountered in each LSeS is largely due to the multidimensional classification property allowed by the latent class analysis. However, the heterogeneous nature of these results calls for a more detailed investigation into what differentiates one stratum from another, as well as what brings distinctive adapted ESeC classes together within a given stratum.

To examine the first issue, we performed a z-test to compare the proportions of household wealth items controlling for Adapted ESeC. For the within-LSeC heterogeneity, we conducted the same tests between the Adapted ESeC classes of LSeC 1. The Adapted ESeC of the household person of reference was used to classify the household's class (Pevalin and Rose 2002; Erikson and Goldthorpe 1992). To obtain the comparisons, we recoded the wealth indicators with three and four categories into dichotomous variables (see Table A3 in Appendix).

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[7] Detailed results on the concomitant variables in the model are given in Appendix (Table A2).

4.3.1. Differences between LSeS controlling for Adapted ESeC

We performed z-tests between LSeS for all categories of Adapted ESeC.[8] To be succinct, we present only the comparisons of the semi- and unskilled class because this is the most extreme case.[9] In fact, the vast majority of occupations in this class are manual and 70.9 percent of the individuals in this category are informal employees, self-employed, and unpaid workers. Nonetheless, 5.9 percent of the individuals in LSeC 1 have semi- and unskilled occupations. The aim is to investigate their presence in this stratum.

The first four columns of Table 7 present the proportions of households in each LSeS according to the wealth indicator. The occupational class refers to the classification of the person of reference in the household. The last three columns show the differences between the indicators. Negative differences mean that the second LSeS in the pair has a greater proportion of better-off households than the first.

=== Table 7 about here ===

The differences between LSeS 1 and LSeS 2 are consistently statistically significant in favor of LSeS 1 except for household and car ownership. The same applies to the differences between LSeS 2 and LSeS 3, excepting piped water into the home, sewage, and waste collection. As discussed before, the disadvantage of LSeS 2 in these three indicators is related to region and place of residence. Accordingly, 23 percent of the households in this class were in rural areas while 40 percent were in small urban areas. Finally, all the differences between LSeS 3 and LSeS 4 are statistically very significant in favor of LSeS 3, except for household ownership.

We found the same hierarchical pattern between the LSeS in the wealth indicators for all the Adapted ESeC classes. It is worth mentioning that the exceptions are differences between LSeS 3 and LSeS 4 within high salariat, low salariat, and intermediate classes. Among individuals in the high salariat class, five out of the twelve differences are not statistically significant compared with three in the low salariat class. In the intermediate occupation class, four differences are not statistically significant. We also found that LSeS 2 was at a disadvantage to LSeS 3 with respect to water supply, sewage, and waste collection in all the Adapted ESeC classes.

Therefore semi- and unskilled adapted ESeC class, on average, tend to be better-off with respect to household wealth if they belong to LSeS 1 than to LSeS 2 which, in turn, tends to be better-off than those in LSeS 3. The same goes for LSeS 3 as opposed to LSeS 4. These findings indicate that in spite of the fact that each LSeS is internally heterogeneous with regard to household wealth, they follow an order irrespective of the individuals' Adapted ESeC. Thus, the wealthiest individuals classified in the semi- and unskilled class tend to be allocated in LSeS 1 while the poorest and least qualified tend to be clustered in LSeS 4.

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[8] Given the sample size, the sample proportion follows asymptotically a normal distribution.
[9] The comparisons between LSeCs for the other categories of Adapted ESeC are available upon request.

4.3.2. Differences within LSeS 1 controlling for adapted ESeC

The second issue refers to the household wealth comparison between different Adapted ESeC classes in the same LSeS, i.e., the within-LSeS differences by class. In order to carry out this comparison, we chose the LSeS 1 because it is the most mixed stratum in terms of the Adapted ESeC class composition. We performed z-tests for the household wealth indicators between adapted ESeC and selected the three pairs with the greatest number of statistically significant differences. Additionally, we compared the extremes: high salariat and semi-, non-skilled households. Table 8 presents the z-test values for the proportion comparisons.[10]

=== Table 8 about here ===

The first three columns of Table 8 show the values for the differences between high and low salariat, intermediate and lower white-collar, and lower white-collar versus blue-collar/skilled classes. Negative differences mean that the second occupational class in the pair has a greater proportion of better-off households.

With respect to the high salariat-low salariat pair, there are eight statistically significant differences out of twelve comparisons. Three of the four non-significant comparisons refer to public services. As for the intermediate versus lower white-collar class comparison, there are six statistically significant differences. Three of these are indicators of greater affluence: number of bathrooms, computer with internet access, car ownership. As for the lower white-collar versus blue-collar/skilled classes, there are five statistically significant differences; however, four of these are negative, favoring the blue-collar/skilled over the lower white-collar. Finally, in the extreme comparison between higher salariat versus semi- and non-skilled classes all are statistically significant except for two differences, i.e. the most expensive items.

The broad picture drawn from the comparisons in Table 8 is that the households in which the person responsible is in a more qualified occupation tend to be in a more advantageous situation than where that person is in a less qualified occupation. Nonetheless, the pattern is not as salient as in the case of comparisons between LSeS controlling for adapted ESeC class. In other words, households in the same LSeS but in different Adapted ESeC classes tend to be less differentiated with respect to the employed wealth indicators than households in the same class but in distinct LSeS.

This difference is more marked when we compare the same class in LSeSs that are more distant from each other. Indeed, the differences between semi-, unskilled households in LSeC 1 and those in LSeC 3 as well as ESeC and LSeC 4 (not shown) are substantially greater than between higher salariat and semi, unskilled households in the same LSeC. As a result, it can be understood that there are subgroups within a given socioeconomic stratum that may constitute class fractions. This would be the case of lower white-collar individuals, lower blue-collar/skilled and semi- and unskilled workers in LSeS 1.

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[10] The full table as well as the tests for the remaining pairs and for the other three ESeC classes are available upon request.

5. External validation

In order to verify whether the latent social stratum (LSeS) is able to discriminate households and individuals according to the ordering found in the analysis of household items and occupational classes, we make use of two variables that did not enter the model. Firstly, we examine the LSeS household composition by food security status, which was the theme of the 2013 National Household Survey's supplementary module. Secondly, we compare the median as well as the mean number of complete years of schooling for individuals over the age 24 by LSeS.

Using a three-month period of reference, the 2013 PNAD inquired about the frequency of events of lack of food due to insufficient resources using fourteen questions; these ranged from being concerned about the likelihood of such an occurrence to not having had a meal due to lack of money. Households without anyone under the age of 18 with at least one and a maximum of five occurrences and households with one or more members under the age of 18 with at least one and a maximum of three such situations were classified as 'light food insecurity status'. 'Moderate food insecurity status' refers to at least six and a maximum of nine out of the fourteen situations in households with no minors and four or five occurrences in households with minors. Finally, households with no minors that experienced at least ten such events and households with minors reporting at least six such situations were classified as 'strong food insecurity status'.

Figure 2 shows that light, moderate and intense food insecurity status increases almost monotonically from LSeS 1 to LSeS 4. While 1.5 percent of the LSeS 1 households experienced moderate or intense food insecurity in the period of reference, this went up to 3 percent among LSeS 2 households, 10.7 percent for LSeS 3 households, and 18.3 percent for LSeS 4 households. The association between LSeC and food insecurity status is statistically significant, with Gamma equals to 0.52, Kendall's Tau-b of 0.27 and Sommer's D of 0.2. The results of the food insecurity indicator in Figure 2 show that the LSeS 4 has the highest proportion of poor households while LSS 1 has the lowest. Proportionally, households in LSeS 2 tend to be better-off than the households in LSeS 3.

=== Fig. 2: Households' food security status by latent socioeconomic stratum - Brazil, 2013 ===

Table 9 presents the mean number of years of schooling as well as the first quartile, the median, and the third quartile for the individuals over 24 years of age by LSeS. The mean number of years of schooling for LSeS 1's, 10.5, equates to incomplete secondary schooling. Nevertheless, LSeS 1's third quartile indicates that one quarter of the individuals in this stratum obtained higher education while LSeS 2's third quartile reveal complete secondary schooling. In fact, 49.6 percent of the persons in LSeS 2 have less than eleven years of schooling while 12.3 percent have completed higher education. Individuals in LSeS 3 and LSeS 4 are by far the least educated. In LSeS 3, 73.1 percent had less than ten years of schooling and 22.2 percent had exactly eleven, i.e., complete secondary schooling. In LSeS 4, 81.4 percent had less than eight years of schooling, i.e., incomplete primary education. Even though the mean number of years of schooling indicates a low overall educational attainment, there is a distinctive descending order from LSeS 1, with the most educated on average, to LSeS 4, with the least educated. The medians also support this finding. Thus, at the individual level, educational attainment by LSeS

indicates the same LSeC ordering pattern found at the household level by means of the food security status.

=== Table 9 about here ===

Both food security status and educational attainment indicators are in agreement with the results on household wealth and occupational class, i.e., LSeS 1 - LSeS 2 - LSeS 3 - LSeS 4, from the better-off to the worst-off. It is important to mention that some LSeS 1 households were classified as moderate and intense food insecurity status, although it was a very small proportion. Moreover, 29.4 percent of the individuals over 24 years of age in this stratum had at most eight years of schooling. On the other hand, 56.9 percent of the LSeS 4 households had not experienced any food insecurity event in the three-month period of reference and a small proportion, 1.5 percent, of those over 24 years of age had attained higher education.

6. Conclusion

We developed and applied a methodology of classification integrating the asset approach, social class schema and socio-demographic indicators that influence the value of goods as well as the households' access to basic services. We did so taking into account specific features of Brazil's constrained labor market and its occupational structure. We use data from the 2013 Brazilian National Household Survey to construct wealth indicators as well as to classify occupations into European Socioeconomic Classification (ESeC) classes. The application of an extended latent class model identified four clusters, termed latent socioeconomic stratum (LSeS). The LSeSs are ordered according to the household wealth level and predominant Adapted ESeC classes. In order to check the classificatory consistency of LSeS, we examined the distributions of two variables not employed in the model: food security status and educational attainment by LSeS. The results indicate that our methodology effectively differentiates the socioeconomic strata. Moreover, it unveils a more complex picture of social stratification.

On one hand, the multidimensional approach and the fine-tuning between wealth, occupation, employment status, and socio-demographic indicators allowed us to detect different social classes within each socioeconomic stratum and, on the other, the same social class across socioeconomic strata. Indeed, individuals may pertain to the same LSeS and be in different ESeC classes. Conversely, individuals may belong to the same social class but be located in distinct LSeS. Accordingly, all social classes are present in the four LSeS and thus each one features a distinctive ESeC composition. Wealth differences of a given ESeC class across socioeconomic strata are more pronounced than differences between social classes within the same LSeS.

In other words, this methodology sets apart socioeconomic strata and discloses a class schema within each one. In doing so, it permits the identification of unexpected ESeC classes in a given socioeconomic stratum. This finding calls for further investigation of the relationships between LSeS and ESeC within and across strata so as to understand the extent to which these subgroups can really be taken as class milieus.

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The criterion validation (Rose et al. 2010) of the LSeSs is another task for the future. However, to the best of our knowledge there is no external parameter or method through which we could accomplish this goal. As for the construct validation, the challenge is to test the hypothesis of whether the same class in different LSeS differentially influences outcomes and life achievements. Rose and colleagues (2010) dispute that the ESeC position conditions household wealth. However, cross-sectional data does not allow establishing that the current occupation, regardless of the individual's sex, age, and family type, brought about a specific level of aggregate wealth or that individuals in a specific ESeC class would have similar levels of aggregate wealth.

In spite of its potential, this methodology calls for a cautionary note as its implementation is complex and requires detailed knowledge about the characteristics of a given society and its labor market. While cross-country comparisons are feasible, they are certainly not easy. On the other hand, we employed data from the National Household Survey, which is carried out annually. This yields comparative analysis over time in the Brazilian case inasmuch as the variables and indicators are compatible and the sampling design remains the same.

APPENDIX

==== Table A1 about here ====

==== Table A2 about here ====

==== Table A3 about here ====

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Tables & Figures

Table 1: Employment status variable

Work Position	Description
Formal employee	Labor contract complying with the Brazilian labor legislation
Public employee	Federal, state or municipal employee, specific contract
Employer	Less than five employees (small) / Five or more (large)
Informal employee	Verbal agreement (monthly payment or on a daily basis)
Self-employed	-
Unpaid worker	Contributing family workers, self-employed for own consumption
Retired	-

Table 2. Adapted ESeC and description

ESeC	Adapted ESeC
ESeC 1: Higher salariat	1 - Higher grade, professional administrative and managerial occupations (public and private sector); large employers (5 or more employees)
ESeC 2: Lower salariat	2 - Lower grade professionals
ESeC 3: Intermediate occupations	3 - Higher administrative and clerical occupations
ESeC 4: nonprofessional occupations excluding agriculture	-
ESeC 5: self-employed and small employers in agriculture, fisheries and forestry	-
ESeC 7: Lower grade white-collar occupations	4 - Lower services, sales and clerical occupations
ESeC 6 & 8: Blue-collar, skilled occupations	5 -Industrial production, repair and maintenance workers
ESeC 9: Semi- and unskilled occupations	6 - Semi- and unskilled occupations; domestic, construction workers
Rural occupations	7 - Agriculture, farming, fishery and forestry workers

Table 3. Distribution of the Latent Socioeconomic Stratum – Brazil, 2013

LSeS	Percentage (weighted observations)	n
1	42.1	78110
2	12.5	29451
3	32.8	69288
4	12.6	26127
Total	100	202976

Data source: PNAD/IBGE (2013).

Table 4. Household/service indicators

Household/Service	Latent Socioeconomic Stratum (LSeS)			
	LSeS 1	*LSeS 2*	*LSeS 3*	*LSeS 4*
Household ownership	Own	Own	Rented	Lent
Dwellers per bedroom	< 2	< 2	≥ 2	≥ 2
Number of bathrooms	2 - 3	1 - 2	1	None - 1
Water supply	Public piped into household (hh)	Well piped into hh	Public piped into hh	None / well piped into hh
Sewage	Public service	Pit latrine / septic well	-	None / pit latrine
Waste collection	Public hh collection	-	Public hh / indirect collection	None

Table 5. Household/services indicators

Indicator:	Latent Socioeconomic Stratum (LSeS)			
Assets	*LSeS 1*	*LSeS 2*	*LSeS 3*	*LSeS 4*
Mobile telephone (individual)	-	-	–	– –
DVD player	-	-	–	– –
Refrigerator	Two-door model	-	One-door model	None
Washing machine	Yes	-	–	– –
Computer & internet	++	+	–	– –
Car/Motorcycle	Car	Car or motorcycle	None	Motorcycle

Table 6. Latent Socioeconomic Stratum (LSeS) by adapted ESeC – Brazil - 2013

Adapted ESeC	Latent Socioeconomic Stratum				Total
	LSeS 1	*LSeS 2*	*LSeS 3*	*LSeS 4*	
Higher salariat	*18.4*	9.4	0.9	0.9	9.3
Lower salariat	*11.4*	9.1	3.5	2.1	7.4
Intermediate occupations	*19.1*	*14.6*	6.4	1.1	12.1
Lower white-collar	*18.3*	*21.2*	*25.9*	7.0	19.7
Blue-collar/skilled	*15.7*	*21.0*	*17.4*	4.8	15.5
Semi- & non-skilled	5.9	9.5	*23.2*	*12.2*	12.8
Agriculture	1.0	11.9	7.5	*63.6*	12.4
Retired	10.3	3.3	*15.2*	8.4	10.8
Total	100	100	100	100	100
n	78110	29451	69288	26127	202976

Data source: PNAD/IBGE (2013).

Table 7: Semi- and non-skilled *Adapted ESeC - z-tests* for proportion comparison of household wealth indicators between LSeC – Brazil, 2013

Indicator	LSeS				LSeS difference		
	1	2	3	4	1 *vs* 2	2 *vs* 3	3 *vs* 4
Own household	0.806	0.801	0.625	0.735	0.005	0.176**	-0.110**
Water piped into household	0.976	0.702	0.923	0.249	0.274**	-0.221**	0.674**
Public sewage service	0.900	0.055	0.580	0.001	0.844**	-0.524**	0.579**
Public waste collection service	0.950	0.884	0.914	0.290	0.066**	-0.031**	0.624**
< 2 dwellers per bedroom	0.871	0.859	0.747	0.668	0.012**	0.112**	0.079**
Two or more bathrooms	0.354	0.278	0.053	0.029	0.075**	0.226**	0.024**
Landline telephone	0.708	0.201	0.125	0.010	0.507**	0.076**	0.114**
Washing machine	0.932	0.726	0.317	0.089	0.205**	0.409**	0.228**
Two-doors refrigerator	0.624	0.511	0.189	0.091	0.112**	0.322**	0.098**
DVD	0.869	0.838	0.680	0.588	0.031*	0.158**	0.092**
Computer with internet access	0.771	0.469	0.135	0.019	0.302**	0.335**	0.116**
Car ownership	0.675	0.727	0.137	0.109	-0.052**	0.590**	0.028**

Data source: PNAD/IBGE, 2013.

** indicate statistical significance at p < 0.01; * indicates statistical significance at p < 0.05.

Table 8: LSeC 1 - *z-test* for proportion comparison of household wealth indicators between selected *Adapted ESeC* classes – Brazil, 2013

Indicator	High *vs* low salariat occup.	Intermediate *vs* lower white-collar occup.	Lower white-collar *vs* blue-collar/skilled occup.	Higher salariat *vs* semi&non-skilled occup.
Own household	0.002	-0.023**	-0.029**	-0.048**
Water piped into household	0.000	0.001	0.001	0.008*
Public sewage service	-0.009	-0.010	0.000	-0.018*
Public waste collection service	-0.006	0.000	-0.013**	0.000
< 2 dwellers per bedroom	0.034**	0.050**	-0.008	0.095**
Two or more bathrooms	0.168**	0.115**	0.003	0.324**
Landline telephone	0.018*	0.002	0.019**	0.053**
Washing machine	0.011*	0.000	-0.002	0.003
Two-door refrigerator	0.053**	0.014	0.013	0.080**
DVD player	0.015**	0.020**	-0.013*	0.041**
Computer with internet access	0.041**	0.071**	0.000	0.154**
Car ownership	0.105**	0.114**	-0.156**	0.207**

Data source: PNAD/IBGE (2013).
** indicate statistical significance at $p < 0.01$; * indicates statistical significance at $p < 0.05$.

Table 9: Mean, first quartile, median and third quartile of number of schooling years by latent socioeconomic stratum – Classified population over 24 years of age, Brazil, 2013

LSeS	Mean	Std Dev	Q1	Median	Q3
1	10.5	100.4	8	11	15
2	8.8	91.3	5	11	11
3	6.2	97.6	3	6	11
4	3.7	87.4	0	3	5

Data source: PNAD/IBGE (2013).

Table A1. Latent class estimates – Characteristics and assets of the households

Wealth variables	Latent Socioeconomic Stratum				Observed
	LSeS 1	LSeS 2	LSeS 3	LSeS 4	proportions
House ownership					
House lent	0.034	0.065	0.067	0.171	0.068
House rented	0.149	0.116	0.252	0.016	0.161
Own House	0.818	0.819	0.681	0.812	0.771
Dwellers per bedroom					
Up to 2	0.917	0.868	0.767	0.746	0.837
More than 2	0.083	0.132	0.233	0.254	0.163
Number of bathrooms in the household					
None	0.001	0.002	0.015	0.183	0.029
1	0.484	0.644	0.903	0.771	0.687
2	0.343	0.298	0.078	0.043	0.208
3 or more	0.172	0.056	0.004	0.003	0.076
Water source					
None	0.001	0.012	0.010	0.281	0.042
Well piped into dwelling	0.019	0.285	0.054	0.454	0.127
Public serv. piped outside dwelling	0.002	0.002	0.008	0.048	0.010
Public service piped into dwelling	0.979	0.702	0.928	0.217	0.821
Sewage service					
None	0.009	0.015	0.041	0.248	0.052
Latrine	0.022	0.401	0.204	0.548	0.209
Septic well	0.108	0.497	0.203	0.200	0.210
Public sewage system	0.860	0.087	0.552	0.003	0.530
Waste collection					
No service	0.001	0.063	0.007	0.762	0.112
Indirect collection	0.042	0.065	0.069	0.056	0.056
Public collection service	0.957	0.872	0.924	0.182	0.832
Landline telephone					
No	0.240	0.748	0.825	0.982	0.610
Yes	0.760	0.253	0.176	0.018	0.390
Mobile telephone (individual)					
No	0.083	0.072	0.245	0.566	0.199
Yes	0.917	0.928	0.755	0.434	0.801
DVD player ownership					
No	0.130	0.180	0.349	0.464	0.255
Yes	0.870	0.820	0.651	0.536	0.745
Refrigerator ownership					
No	0.000	0.002	0.020	0.141	0.026
Yes, 1 door	0.351	0.520	0.768	0.742	0.568
Yes, 2 doors	0.649	0.478	0.212	0.117	0.407
Washing machine ownership					
No	0.074	0.303	0.660	0.889	0.412

Yes	0.926	0.697	0.340	0.112	0.588
Computer and internet access					
No computer	0.131	0.304	0.754	0.946	0.473
Computer, no internet access	0.053	0.149	0.068	0.032	0.069
Computer and internet access	0.817	0.547	0.178	0.023	0.457
Car / Motorcycle ownership					
None	0.211	0.153	0.701	0.515	0.408
Motorcycle	0.035	0.186	0.155	0.316	0.135
Car	0.628	0.418	0.120	0.103	0.357
Car and motorcycle	0.126	0.243	0.024	0.066	0.101

Table A2. Latent class estimates – Profiling variables

| Profiling variables | Latent Socioeconomic Stratum | | | | Observed |
	LSeS 1	LSeS 2	LSeS 3	LSeS 4	proportions
Adapted ESeC					
Higher salariat	0.182	0.092	0.010	0.009	0.088
Lower salariat	0.112	0.090	0.037	0.021	0.071
Intermediate white-collar	0.182	0.147	0.067	0.012	0.116
Lower white-collar	0.169	0.214	0.252	0.072	0.191
Blue-collar/Skilled	0.136	0.200	0.162	0.047	0.143
Semi- & non-skilled	0.054	0.096	0.216	0.124	0.124
Agriculture	0.008	0.093	0.061	0.577	0.113
Retiree	0.157	0.068	0.196	0.138	0.154
Employment status					
Employee - Brazilian Labor Legislation	0.434	0.397	0.349	0.095	0.356
Public servant	0.097	0.101	0.025	0.020	0.063
Informal employee	0.108	0.155	0.235	0.217	0.172
Self-employed	0.142	0.193	0.169	0.250	0.173
Employer	0.054	0.041	0.004	0.007	0.029
Unpaid worker	0.009	0.044	0.023	0.273	0.053
Retired	0.157	0.068	0.196	0.138	0.154
Family type					
One-dweller Household	0.041	0.021	0.126	0.074	0.071
Couple no children	0.162	0.161	0.171	0.196	0.169
Couple/Mother all children < 14 yrs	0.163	0.219	0.200	0.200	0.189
Couple/Mother all children >= 14 yrs	0.409	0.325	0.250	0.250	0.322
Couple/Mother children >=< 14 yrs	0.094	0.138	0.092	0.145	0.107
Extended family	0.071	0.098	0.081	0.086	0.080
Other type	0.059	0.037	0.081	0.049	0.062
Place of residence					
Rural area	0.003	0.183	0.016	0.848	0.144
Small urban area	0.168	0.358	0.364	0.096	0.253
Large urban area	0.264	0.315	0.259	0.034	0.240
Metropolitan area	0.566	0.145	0.361	0.022	0.363
Region of residence					
North	0.037	0.276	0.144	0.295	0.142
Northeast	0.149	0.186	0.376	0.469	0.273
Southeast	0.494	0.059	0.280	0.110	0.307
South	0.217	0.301	0.107	0.067	0.173
Center-West	0.103	0.178	0.093	0.059	0.105
Sex					
Male	0.511	0.558	0.528	0.611	0.537
Female	0.489	0.442	0.472	0.389	0.463
5-year age group					
15-19 yrs	0.038	0.064	0.061	0.079	0.055
20-24 yrs	0.084	0.110	0.112	0.088	0.098
25-29 yrs	0.100	0.114	0.116	0.092	0.106

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30-34 yrs	0.118	0.136	0.114	0.097	0.116
35-39 yrs	0.109	0.131	0.098	0.093	0.107
40-44 yrs	0.104	0.121	0.085	0.088	0.098
45-49 yrs	0.102	0.102	0.075	0.083	0.090
50-54 yrs	0.094	0.077	0.067	0.078	0.080
55-59 yrs	0.076	0.057	0.060	0.078	0.068
60-64 yrs	0.060	0.038	0.054	0.070	0.056
65-69 yrs	0.044	0.024	0.049	0.055	0.044
70 and over	0.073	0.028	0.110	0.101	0.082

Table A3. Dichotomization of the three- and four-category wealth indicators

Indicator	1	0
Home ownership	Own home	Remaining categories
Water source	Water piped into household	Remaining categories
Waste collection	Waste service	Remaining categories
Number of bathrooms	2 or more	Remaining categories
Refrigerator	Two-door refrigerator	Remaining categories
Computer and internet access	Computer with internet access	Remaining categories
Car ownership	Car and car/motorcycle	Remaining categories

| Labor occupation | → | Latent Socioeconomic Stratum (LSeS) | → | Assets |

Profiling variables　　　　　**Latent class**　　　　　**Manifested variables**