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INTR-AGENT HETEROGENEITY IN URBAN FREIGHT DISTRIBUTION: THE CASE OF OWN ACCOUNT OPERATORS

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Intra-agent heterogeneity in urban freight distribution: the case of own-account operators

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ABSTRACT

Urban freight distribution policies aim to improve the efficiency of deliveries of goods in cities. Local policy makers intervene on rooted, complex and pre-existent relationships. Various are the agents, both collaborating and competing, involved in providing and buying freight distribution services. Retailers, transport providers and own-account agents are among the most important actors; they are all potentially characterized both by inter and intra agent heterogeneity in preferences. Heterogeneity in preferences, whenever present, has relevant implications for policy intervention. There is a knowledge gap related to the peculiarities of these agents’ preferences and behavior, notwithstanding some recent attempts to bridge it, that call for a thorough agent-specific analysis. This paper focuses on urban freight distribution with specific reference to the impact that variations of policy characteristics (e.g. time windows, number of loading and unloading bays, entrance fees, etc.) might cause on own-account agents’ behavior. It is important to underline that, de facto, own-account agents are among the least studied operators in this context. This lack of attention is mostly attributable to the toil needed to acquire relevant data to study their preferences and behavior. This lack of knowledge has favored the birth of a widely accepted presumption concerning their inefficiency that, in turn, has produced specifically targeted policies often hindering their activities. This paper reports the empirical results of a study conducted in the limited traffic zone in Rome’s city center in 2009 thanks to a Volvo Research Foundation grant. The analysis is based on a comprehensive and representative data set including: 1) general information on the respondent, 2) company characteristics, and 3) stated ranking exercises. The ranking data were subsequently transformed in choice data. The paper describes own-account operators’ preferences as they emerge from the stated ranking exercises and proposes a systematic comparison among them via willingness to pay measures. The compared estimates are derived under different assumptions concerning agents’ preference heterogeneity. More in detail we discuss results assuming: 1) no heterogeneity (multinomial logit), 2) covariates-explained heterogeneity (multinomial logit including interactions with relevant socio-economic variables), 3) flexible heterogeneity (investigating the systematic and stochastic components of the utility function). Heterogeneity analysis, apart from relevant theoretical implications, has important policy repercussions in as much as it impacts on the willingness to pay measures of the policies implemented. An appropriate treatment of heterogeneity is therefore functional to obtaining undistorted and reliable policy forecasts to be fed to micro simulation models used to support the decision-making process. The paper: 1) addresses methodologically relevant issues, 2) uses a new, detailed and significant data set, 3) tackles policy relevant questions, 4) provides worthwhile information for policy-makers. The estimation of willingness to pay / willingness to accept measures for hypothetical policies sets a benchmark for policy makers and researchers alike.
Keywords: urban freight distribution; own-account; preference heterogeneity, freight policy evaluation.

1. Introduction

Urban freight distribution (UFD) policies aim to improve the efficiency of deliveries of goods in cities. Local policy makers intervene on rooted, complex pre-existent relationships. Various are the agents, both collaborating and competing, involved in providing and buying freight distribution services.

Retailers, transport providers and own-account agents are among the most important actors in UFD. Recent researches show that these actors are characterized both by inter and intra agent preference heterogeneity (Marcucci and Gatta, 2013; Gatta and Marcucci, 2013; Stathopoulos et al., 2012; Massiani, 2008). These considerations potentially bear relevant implications for policy intervention. In fact, the distortions an inappropriate treatment of heterogeneity, once its presence is relevant, might have on policy decisions are substantial.

Current UFD literature still lacks a thorough investigation of the specific preferences, needs, and concerns of these agents. This circumstance is prevalently attributable to the scarcity of appropriate data. In fact, few studies have tackled this specific research issue from an agent-specific perspective, notwithstanding the widely recognized need to analyze the potentially diversified policy effects (Ogden, 1992).

These considerations assume a particular role when studying the complex environment within which UFD agents operate. Present research calls for a focus at the agent-specific level (Liedtke et al. 2006). Policy interventions in freight transport, in general, and in UFD, in particular, often produce undesired results when behavioral and contextual aspects are not explicitly considered.

This paper focuses on UFD agent-specific policy analysis. It aims at filling a knowledge gap by studying own-account operators, which are, among the most important agents involved in UFD, the least investigated. Daunting data acquisition problems are at the base of this limited attention. This has generated the widely accepted and mostly unjustified presumption concerning the relative inefficiency of own-account operators (Danielis et al., 2010) that has also induced the implementation of penalizing policies specifically aimed at this agent category. Why would one study own-account operators if their number should be reduced given their (untested) inefficiency? Danielis et al. (2010) have recently questioned own-account allegedly inferior efficiency and underlined the highly diversified situation among freight sectors and supply chains. Newly acquired evidence suggests policy-makers should not adopt blunt policy instruments expecting a homogeneous response. In fact, our results confirm the presence of substantial preference heterogeneity among own-account operators and warn against a simplistic study of preferences given the biases this might cause.

The paper reports the results of a study conducted in the limited traffic zone (LTZ) in Rome’s city center. The analysis uses a detailed data set including: 1) general information about respondents; 2) company's characteristics; 3) stated ranking exercises (SRE). In the SRE interviewees were presented with alternative policy scenarios and had to rank them according to their preferences. The ranking data were subsequently
appropriately transformed into choice data.

Own-account operators’ preferences, as it emerges from the SRE, are derived under different assumptions concerning agents’ preference heterogeneity. A systematic comparison is performed via willingness to pay (WTP) and willingness to accept (WTA) to account for different assumptions on both the deterministic and stochastic part of utility in a random utility maximization context (Marcucci and Gatta, 2012). This approach allows interesting insights on the implications distorted forecasts might have on micro simulation models used for ex-ante policy impact evaluation.

Various manifestations of heterogeneity are investigated and tested in this paper. More in detail, we discuss results assuming: 1) no heterogeneity according to a multinomial logit (MNL) specification, 2) covariates-explained heterogeneity using MNL plus interactions with relevant socio-economic variables (MNLS-E), 3) flexible heterogeneity considering the model which provides the best fit to the data, in this case, the latent class (LC) specification. The econometric analysis supports the existence of 2 distinct classes of people in the sample.

The practical implications deriving from the different ways used to search for intra-agent heterogeneity are compared using WTP/WTA measures that help identifying markedly different welfare effects the alternative policies might provoke.

The rest of the paper is structured as follows. Section 2 reports a brief overview of the relevant literature concerning agent-type analysis for UFD. Section 3 succinctly describes the study context, while section 4 reports the development of the survey instrument and comment the data. The econometric results are reported in section 5. Section 6 concludes and addresses future research efforts.

2. Literature review

Freight transport literature has recently witnessed a concomitant upsurge of interesting, detailed and articulated reviews describing, from different perspectives, the development of several modeling approaches, the current state of the art and the most likely evolutions (Nuzzolo et al., forthcoming; Melo, forthcoming).

Nuzzolo et al. (forthcoming), when reviewing short distance freight transport modeling, underline that, in recent years, the main driver of model development has been the need to find solutions for the forecasting and management of freight vehicles flows in urban areas. The various contributions have been flanked by numerous papers proposing alternative classification methodologies. Starting from Ogden (1992) who proposed a classification based on quantities moved (commodity-based) and on vehicles (truck-based), one can move to Regan and Garrido (2001) who suggested a classification focusing on the model structure used to identify the two approaches reported above both leading to the construction of freight origin–destination matrices. Regan and Garrido (2001) illustrate and discuss gravity models (derived from the passenger modeling tradition) and input-output models (derived from a macro-economic modeling approach also including spatial price equilibrium models that are, indeed, more suitable for modeling extra-urban freight movements). Furthermore, Ambrosini and Routher (2004) report a detailed classification of various freight policy-oriented models applied in different European countries while Chow et al. (2010) review the recent advances in freight forecasting models focusing, in particular, on data needs and
interpreting urban freight models as a component of two broader modeling classes: logistic and routing models. Comi et al. (2012) suggest a classification of demand models based on short-term assessment and decision-making support capabilities. More in detail, Comi et al. (2012) discuss the recent and sophisticated model class deriving from the integration of two previously distinct research streams: one aimed at simulating the level and spatial distribution of commodity flows within cities (intra-city origin destination matrices) and the second focusing on route choice and traffic assignment.

Melo (forthcoming) adopts a different classification strategy. A relevant reflection concerns the fact that freight transport models are usually developed at a national or international scale (Pendyala et al., 2000; Regan and Garrido, 2001; WSP, 2002; ME&P, 2002a; ME&P, 2002b; de Jong et al., 2004; Tavasszy, 2006; Yang et al., 2010) in contrast with what happens for passenger ones. Data availability and interest in long trips are the most important explanatory variables of the scarce development of freight models dealing with the urban scale. Melo concentrates on the identification of the most relevant freight modeling examples developed for the urban level (e.g. Boerkamps and Binsbergen, 1999; Regan and Garrido, 2001; Taniguchi et al., 2003; ME&P, 2002; Groothedde, 2005; Yang et al., 2010) where models categorical separation is based on the ‘commodity versus vehicle movements’ or ‘aggregate versus disaggregate’ approach.

An additional categorization proposed relates to the systemic or operational nature of the models developed thus distinguishing whether the modeler’s aim mostly focuses on a planning or operational level (Paglione, 2006). Systemic models are suitable for the: a) strategic level, concerned with system design and evaluation; b) tactical level, centered on operations planning and control (see Crainic et al., 2009). Systemic models usually reflect public objectives, related to stakeholders’ well-being, life quality, and mobility. On the other hand, operational models are characterized by a narrower scope often focused on specific stakeholders groups (usually private suppliers and transport providers) and their activities and objectives, primarily aimed at improving distribution efficiency and profits.

A series of recent papers (Stathopoulos et al., 2012; Marcucci and Gatta 2013, Gatta and Marcucci, 2013) have reported and discussed new and interesting findings deriving from a behavioral approach to UFD. Among the first contributions in this emergent stream of research one recalls Hensher and Figliozzi (2007) that persuasively claim that standard approaches underestimate the complexity of freight movements at different geographical scales thus missing potentially relevant motivations capable of explaining agents’ behavior within current scenarios. Stakeholders’ utility maximization is explicitly considered in behavioral models that represent a sub-set of disaggregate freight models. The appropriate estimation of these models relies on the correct identification of key decision-makers. Notwithstanding this might sound obvious, in the case of freight, it de facto represents a very controversial and daunting issue. Understanding who actually decides about freight choice movements is not an easy task since there are many actors potentially influencing the final decision. The development of an agent-based modeling framework capable of describing and forecasting the behavior of specific actors necessitates an a priori identification of a decision maker for each given action considered necessary for freight transportation (Liedtke and Schepperle, 2004; Marcucci, forthcoming).

Agent-based micro models are, according to several authors (Gray, 1982; Wisetjindawat et al., 2006; de Jong and Ben-Akiva, 2007; Hensher and Figliozzi, 2007; Samimi et al., 2009; Yang et al., 2009; Roorda et al., 2010) an appropriate instrument to model UFD. In fact, policies impacting on fuel prices, land use patterns and pricing strategies modify the comparative convenience of different UFD options. Joint consideration of policy instruments and the attributes influencing freight behavior is fundamental to understand and correctly predict the impacts policies might produce on market outcomes (Puckett and Greaves, 2009).
Policy makers need to identify incentives/disincentives with a relevant impact and quantify the effects they would produce by comparing them with what occurs in the reference scenario faced by the agents. The three most important issues a behavioral model for freight transportation has to deal with are: 1) pinpointing the decision makers involved, 2) clarifying operational constraints and 3) understanding inter-agent interactions. This paper focuses on the first point, that is, the role and preference of own-account operators which, in the context studied, play a relevant role (Danielis et al., 2011).

3. The study context: the roman freight limited traffic zone

The data used in this paper were collected between March and December in 2009 thanks to a Volvo Research Foundation grant (Volvo Report, 2010). In the late eighties the LTZ in Rome’s historical center was first introduced. A 5km$^2$ area was restricted to non-residents’ vehicles and bans on traffic, now applying both to passenger and freight, were imposed. A specific regulation characterizes the LTZ area; only Euro 1 and more fuel-efficient vehicles are allowed to enter. Free access is awarded only to residents; all other vehicles pay an access fee. The scheme is enforced, during daytime, using cameras and each vehicle pays a 565 € per year fee. Time windows regulations selectively apply to entrants. Own-account operators are specifically targeted and substantial exemptions apply to third party freight operators. The regulatory framework is designed to: (1) foster the adoption of third party freight transport providers; (2) discourage lengthy parking; (3) reduce the number of vehicles entering the LTZ area. Time windows are, regretfully, not systematically enforced.

4. Study context and survey instrument description

Back in the ‘90s Ogden (1992) already underlined that receivers, carriers and forwarders are the most important stakeholders to consider in UFD analysis. The survey instrument was developed to study: carriers, retailers and own-account operators. The first two operators have been studied in the literature. Stathopoulos et al. (2011), on the base of stakeholder consultations, suggest investigating own-account operators too. The first step in developing a survey instrument with this intent, is to define, select and customize the attributes to be used for preference elicitation exercises.

The stakeholders’ consultation conducted allowed for realistic attribute definition and contextualization. Section 4.1 highlights and motivates the attribute selection process. Ex-ante joint policy acceptability was the most important attribute selection criterion used. Subsequently, the paper describes how each attribute was: 1) defined; 2) structured in levels; 3) assigned specific ranges; 4) progressively differentiated by agent type. Attribute selection was initially guided by previous stakeholder surveys.

4.1. Attributes included in the Stated Ranking Exercise
Each alternative in the SRE is described by a set of attributes that take several levels and span for different variation ranges when the alternatives are presented to respondents\(^1\). The attributes were derived from three sources: a) literature survey; b) previous studies on freight distribution in Rome; c) focus groups with representative stakeholders. We conducted an extensive review on city logistics literature especially focusing on those papers adopting an agent-based approach.

Attribute selection started with reviewing previous studies on city logistics conducted in Rome (STA, 2001; Filippi and Campagna, 2008). Stakeholder surveys were also very useful in reaching a final decision\(^2\). All stakeholders considered the attributes selected relevant. The attributes, finally piloted with operators, were: 1) number of loading and unloading bays (LUB); 2) probability to find loading/unloading bays free (PLUBF); 3) entrance fees (EF); 4) time windows (TW). All these attributes have been considered as possible components of a policy-package (Marcucci et al., 2012).

### 4.2. Agent-type differentiations

Given the limited budget available for the interviews an efficient design strategy was adopted. Attributes have progressively been differentiated by respondent-type (own-account; retailers; transport providers) after the piloting phase. Relevant and pertinent to own-account operators is the inclusion of the TW attribute.

In fact, after stakeholders’ consultations, it was evident that own-account operators alone are de facto facing TW restrictions. The SRE contained three policy options including the status quo (SQ) alternative. Agents were asked to rank policies according to their preferences. Table 1 reports an example of a SRE task.

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Policy 1</th>
<th>Policy 2</th>
<th>Status Quo</th>
</tr>
</thead>
<tbody>
<tr>
<td>LUB</td>
<td>400</td>
<td>800</td>
<td>400</td>
</tr>
<tr>
<td>PLUBF</td>
<td>20%</td>
<td>10%</td>
<td>10%</td>
</tr>
<tr>
<td>EF</td>
<td>1000 €</td>
<td>200 €</td>
<td>600 €</td>
</tr>
<tr>
<td>TW</td>
<td>20:00-10:00/14:00-16:00</td>
<td>04:00/20:00</td>
<td>20:00-10:00/14:00-16:00</td>
</tr>
<tr>
<td>Policy ranking</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
</tbody>
</table>

The levels of the attributes were considered plausible, policy relevant and easy to implement. The attributes, levels, and ranges used are reported in Table 2.

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Number of levels</th>
<th>Range of attribute (status quo underscored)</th>
</tr>
</thead>
</table>

\(^1\) Please refer to Stathopoulos et al. (2011) for a clear motivation of choosing stated ranking as an elicitation mechanism.

\(^2\) An important phase of focus groups with experts focused on the definition of policies capable of mitigating the identified UFD problems. Volvo Report (2010) provides a detailed overview of stakeholders survey results as well as of attributes used in the SRE.
It is important to note that for the TW attribute the two hypothetical variations imply the same amount of hours of allowed entrance to the LTZ as the SQ situation. The difference between the levels considered consists not in the quantity of hours available for entering the LTZ but, rather, in the specific hours added or subtracted to the SQ.

In particular TW1 subtracts two hours (08:00-10:00) in the morning (the most frequently used to perform deliveries and, thus, the most preferred) and adds the same quantity in the afternoon (18:00-20:00). It is assumed that TW1 will have a negative impact on utility. TW3, on the contrary, subtracts 8 hours during the night (20:00-04:00) and adds the same amount during the day in two different time slots (10:00-14:00 and 16:00-20:00) thus de facto making entrance always possible during working hours. It is assumed that TW3 will have a positive impact on utility.

4.3. Data description

The results reported are part of a larger research project financed both by Volvo Research Foundation aimed at UFD policy definition and implementation. A total of 252 interviews were administered but only 229 were finally used after discarding pilot interviews. The sample is composed of 73 own-account operators, the only one used in this paper, 90 retailers and 66 transport providers.

5. Econometric results

In this section we report the econometric results, for own-account operators using the data sample elicited via the SRE described\(^3\).

The econometric strategy adopted in this paper focuses on detecting intra-agent preference heterogeneity. As suggested by Marcucci and Gatta (2012) the search for heterogeneity might be performed in different ways. In fact, heterogeneity can be explored by investigating the systematic, stochastic or systematic and stochastic components of the utility function. Each search endeavor can be performed with a varying level of sophistication independently of which part of the utility function is studied.

\(^3\) For a detailed discussion of the methodological framework and possible applications of discrete choice models to similar context. See, for example, Marcucci (2011); Gatta (2006).
When investigating the systematic part of utility one could adopt the following model specifications: 1) MNLSE, 2) Mixed Logit (ML), 3) LC.

On the other hand, when focusing on the stochastic part of utility the researcher could specify the following models: 1) Error Component (EC), 2) Covariance Heterogeneity (COVHET).

If, finally, one aims at investigating heterogeneity in both the systematic and stochastic part of the utility function, the model specification that could be used to this end is a ML with an EC component (MLEC).

The results obtained applying the search strategy to the available sample are reported in what follows.

We first adopt a simple MNL model assuming perfect preference homogeneity as a benchmark (M1). With reference to (M1) one notices that both LUB and PLUBF are not statistically significant while EF and TW are significant and with the expected sign (see Table 3). (M1) also includes two alternative specific constants (ASCs) for the unlabeled hypothetical cases (ASC_Alt1, ASC_Alt2) whose coefficients represent the overall alternative impact on own-account utility when all the coefficients of the other attributes are zero. In our case, results show that, there is an a priori evaluation against the SQ.

The overall model fit is acceptable (adj-rho² = 0.14). From a policy perspective it is important to calculate which are the WTP/WTA for attributes’ variations. In particular, the only WTP/WTA values that could be calculated are those related to the TW attribute since this is, for this specification, the only statistically significant attribute along with EF. The agents interviewed are willing to pay 197 € for TW3 while are willing to accept TW1 for 228 €.

Assuming preference homogeneity would induce the analyst to conclude that the sampled agents are not willing to pay neither for LUB nor for PLUBF. This issue will be further discussed in the following paragraphs.

Table 3 – MNL model estimates (M1)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>St.Err.</th>
<th>T-Stat</th>
<th>WTP/WTA*</th>
</tr>
</thead>
<tbody>
<tr>
<td>LUB</td>
<td>-0.067</td>
<td>0.057</td>
<td>-1.18</td>
<td>-</td>
</tr>
<tr>
<td>PLUBF</td>
<td>-0.008</td>
<td>0.052</td>
<td>-0.16</td>
<td>-</td>
</tr>
<tr>
<td>EF</td>
<td>-0.768</td>
<td>0.052</td>
<td>-14.65</td>
<td>-</td>
</tr>
<tr>
<td>TW1</td>
<td>-0.875</td>
<td>0.080</td>
<td>-10.91</td>
<td>-228 [-265, -193]</td>
</tr>
<tr>
<td>TW3</td>
<td>0.756</td>
<td>0.079</td>
<td>9.63</td>
<td>197 [160, 237]</td>
</tr>
<tr>
<td>ASC_Alt1</td>
<td>0.936</td>
<td>0.151</td>
<td>6.20</td>
<td>-</td>
</tr>
<tr>
<td>ASC_Alt2</td>
<td>0.784</td>
<td>0.128</td>
<td>6.14</td>
<td>-</td>
</tr>
</tbody>
</table>

* in brackets the confidence intervals using Krinsky-Robb method with 10,000 pseudo-random draws from the unconditional distribution of the estimated parameters.

A MNLSE specification represents a first attempt to investigate heterogeneity. This naïve approach to heterogeneity assumes socio-economic variables are capable of differentiating attributes’ impact among agents (M2). The MNLSE specification produces a better fit to the data with a statistically improved adj-rho² = 0.17. Also in this case it is interesting to note that both LUB and PLUBF are not statistically significant and,
therefore, a naïve treatment of heterogeneity would also induce the analyst to assume agents are not willing to pay neither for LUB nor for PLUBF. This issue will be further investigated in what follows.

The socio-economic variables tested for explaining heterogeneity among agents are: 1) number of employees (NOE), 2) shop dimension (SD), 3) frequency of deliveries (FOD), 4) freight sector (FS), 5) own-account level (OAL), that is, self-stated percentage of own-account transportation performed with reference to the total amount of deliveries, 6) EURO vehicle standard (EVS), 7) number of deliveries (NOD). The first five socio-economic variables have produced, at least partially, some statistically significant results that are reported in table 4 below.

**Table 4 – MNLSE model estimates (M2)**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>St.Err.</th>
<th>T-Stat</th>
</tr>
</thead>
<tbody>
<tr>
<td>LUB</td>
<td>-0.054</td>
<td>0.058</td>
<td>-0.95</td>
</tr>
<tr>
<td>PLUBF</td>
<td>-0.038</td>
<td>0.054</td>
<td>-0.70</td>
</tr>
<tr>
<td>EF</td>
<td>-0.097</td>
<td>0.208</td>
<td>-0.47</td>
</tr>
<tr>
<td>TW1</td>
<td>-0.783</td>
<td>0.155</td>
<td>-5.04</td>
</tr>
<tr>
<td>TW3</td>
<td>0.446</td>
<td>0.117</td>
<td>3.82</td>
</tr>
<tr>
<td>EF_FS3</td>
<td>-1.836</td>
<td>0.410</td>
<td>-4.48</td>
</tr>
<tr>
<td>EF_NOE</td>
<td>0.028</td>
<td>0.010</td>
<td>2.73</td>
</tr>
<tr>
<td>EF_SD</td>
<td>-0.318</td>
<td>0.093</td>
<td>-3.41</td>
</tr>
<tr>
<td>TW1_FOD</td>
<td>0.137</td>
<td>0.058</td>
<td>2.36</td>
</tr>
<tr>
<td>TW1_OAL1</td>
<td>-0.422</td>
<td>0.158</td>
<td>-2.66</td>
</tr>
<tr>
<td>TW1_OAL2</td>
<td>-0.699</td>
<td>0.141</td>
<td>-4.96</td>
</tr>
<tr>
<td>TW1_FS3</td>
<td>0.684</td>
<td>0.291</td>
<td>2.35</td>
</tr>
<tr>
<td>TW2_OAL1</td>
<td>0.444</td>
<td>0.173</td>
<td>2.57</td>
</tr>
<tr>
<td>TW2_OAL2</td>
<td>0.635</td>
<td>0.160</td>
<td>3.98</td>
</tr>
<tr>
<td>ASC_Alt1</td>
<td>0.968</td>
<td>0.155</td>
<td>6.23</td>
</tr>
<tr>
<td>ASC_Alt2</td>
<td>0.799</td>
<td>0.131</td>
<td>6.10</td>
</tr>
</tbody>
</table>

(M2) results suggest the presence of some form of intra-agent heterogeneity. In fact, without going too much into details, one sees that: 1) agents belonging to Sector 3 are more sensitive to EF variations while less sensitive to TW1; 2) an increase in the number of employees and/or in the frequency of deliveries both

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4 Since, *de facto*, there are no operators that only self-produce the transportation services they need, we used this information in the estimation process. In particular, this variable was used to categorize the operators in three classes. When the self-production percentage of the transportation services needed is, for example, at least 80% of the total the variable takes the value of 1, whereas it takes the value of 2 when the self-production is between 30% and 80%, and 3 in the remaining cases (1 = strong own-account characterization; 2 = medium own-account characterization; 3 = low own-account characterization).

5 The macro sectors are: 1) food (fresh, canned, drinks, tobacco, bars, hotels and restaurants); 2) personal and house hygiene (detergents, pharmaceuticals, cosmetics, perfumes, watches, barbers, etc.); 3) stationery (e.g. paper, newspapers, toys, books, CDs etc.); 4) house accessories (e.g. dish washers, computers, telephones, metal products etc.); 5) car accessories (e.g. vehicle components, gasoline, etc.); 6) services (e.g. laundry, flowers, live animals, accessories and animal food, etc.); 7) clothing (cloth, leather, etc.); 8) construction (e.g. cement, scaffold, chemical products, etc.); 9) other (all that was not included in previous categories).
produce a reduction of the sensitiveness to EF variations; 3) increasing shop dimension positively impact on EF sensitivity; 4) agents’ medium or strong own-account characterization (see footnote n° 4) provokes a higher negative sensitivity to TW1 (undesirable TW level) and, inversely a higher positive sensitivity to TW3 (desirable TW level).

A further sophistication in the search for heterogeneity can be achieved by assuming an underlying distribution of the agents’ preference parameters. ML is similar to LC even if it embodies several important differences (Greene and Hensher, 2003). One of the large virtues of ML is that in the simulated likelihood function (see Gourieroux et al., 1994 and Train, 2003 for a discussion of maximum simulated likelihood estimation of this model) one is not limited to using the normal distribution since the components of the deterministic part of the utility may be drawn from different distributions. We would use this model to investigate the presence of continuous forms of heterogeneity and test non-normal continuous parameter distributions. However, in this case, ML did not produce a better fit to the data and only one standard deviation was found to be statistically significant.

At this point one could be tempted to revert to the simple MNLSE where only some socio-economic variables explain heterogeneity in own-account operators’ preferences. Nevertheless, following Marcucci and Gatta (2012), one last attempt, when investigating the deterministic part of the utility, is in order. In other words, one has to check whether there is a form of discrete mixture of heterogeneity among agents by estimating a LC model (M3). The finite mixture approach to conditional logit models is developed and latent classes are used to promote an understanding of systematic heterogeneity (Boxall and Adamowicz, 2002). This helps uncovering unobserved heterogeneity in a population and finding substantively meaningful groups of people that are similar in their responses to measured variables (Muthén, 2004).

(M3) is reported in Table 5. The two main points that need underlining relate to: 1) the detection of discrete heterogeneity among agents such that two different latent classes are identified; 2) PLUBF is now statistically significant for one of the two latent classes estimated notwithstanding it was never so in any of the previous model specifications.

(M3) represents a significant improvement with respect to (M2) in terms of fit to the data (Adj Rho² = 0.24). The two classes detected among the agents sampled are quite distinct in terms of preferences. In fact, whereas class 1 (C1, with class probability equal to 50%) is more sensitive, in relative terms, to TW variations whereas for class 2 (C2) EF is the most important attribute with a role also played by PLUBF. In fact, looking at WTP and WTA estimates one can notice that agents in (C1) are ready to pay 360€ for TW3
and to accept 466€ for TW1 while agents belonging to (C2) have substantially lower values for both WTP and WTA measures respectively equal to 102€ and 54€. Moreover, for (C2) PLUBF is now relevant in explaining choice suggesting that there is a class within the sample that considers PLUBF a relevant attribute. More in detail, this class of agents are ready to pay 27€ for an increase in 10% base points of finding a loading and unloading bay free. This WTP has a magnitude not comparable to other variables but still, should it not be explicitly considered, would provoke a distortion of the estimates.

We further investigated heterogeneity by searching the stochastic part of utility via EC and COVHET model specifications. None of the two models estimated provided statistically significant results and, consequently, no improvement in explanatory power. This suggests there is no heterogeneity in the stochastic part of utility among the sampled agents. These results imply that the search for heterogeneity in both the stochastic and deterministic part of the utility (e.g. MLEC) is superfluous.

To sum up the results obtained one could say that heterogeneity has to be investigated systematically and following a well-defined search strategy. Abandoning attribute investigation beforehand is not a recommendable strategy. In fact, one could have stopped searching for heterogeneity after estimating a ML model in which no significant standard deviations are detected for the attributes considered and thus reverting to a simple MNL model. However, this would have provoked two major problems. On one side one would have not discovered the presence of a discrete form of heterogeneity among agents (C1 and C2) and, on the other, the PLUBF attribute would have been erroneously considered irrelevant in the decision making process. The measures of these potential distortions are reported in Table 6.

<table>
<thead>
<tr>
<th>Variable</th>
<th>MNL</th>
<th>LC</th>
<th>MNL distortion</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>C1</td>
<td>C2</td>
<td>C1 (weight: conditional class membership prob.)</td>
</tr>
<tr>
<td>TW1</td>
<td>WTA: 228€</td>
<td>WTA: 466€</td>
<td>WTA: 54€</td>
</tr>
<tr>
<td>TW3</td>
<td>WTP: 197€</td>
<td>WTP: 360€</td>
<td>WTP: 102€</td>
</tr>
<tr>
<td>PLUBF</td>
<td>WTP: 0€</td>
<td>WTP: 0€</td>
<td>WTP: 27€</td>
</tr>
</tbody>
</table>

From a public perspective, using a simple MNL specification for WTP/WTA measures determination, would induce adopting inefficient policy measures. In fact, taking the case of TW1 as an example, if using a MNL specification the local policy makers would assume own-account operators need an EF reduction of 228€ to accept the restrictive measure. However, this action, taking the unconditional class membership probabilities, would imply an overestimation of the WTA for (C2) (+ 174€) and an underestimation for (C1) (-240€) with a total efficiency loss of around 414€. Taking, instead, the conditional class membership probabilities one notices that there is a 38% probability of belonging to (C1) and 62% to (C2). Assuming these probabilities as relevant for the agents sampled, the distortions deriving from the erroneous heterogeneity assumptions would induce an overall loss of efficiency equal to 199€. An error of similar amount would be induced for TW3.

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6 Values not reported for reasons of brevity are available upon request from the corresponding Author.
6. Summary, conclusions and future research

This paper has investigated own-account operators’ preferences for UFD policy interventions. It helps bridging a knowledge gap in UFD research literature by investigating intra-agent heterogeneity. The paper is based on an original and detailed dataset that overcomes data availability issues that typically constrain research efforts in this specific domain. Data were collected in 2009 in Rome’s LTZ.

Notwithstanding the limited number of sampled agents the results obtained suggest the presence of relevant intra-agent heterogeneity. More in detail, the search strategy adopted allowed for the identification of a naïve form of heterogeneity by simply using some socio-economic variables. However, more interesting from a policy perspective, is the discovery of two latent classes within the agents sampled and the relevance in explaining heterogeneity of an attribute (PLUBF) that was never statistically relevant in any previous model specification. The policy implications of the model mis-specification are quantified by calculating WTP/WTA measures and their respective confidence intervals.

The restricted number of observations, due to the limited budget available, represents a limitation. Should further funds be secured in the future, an extension in the coverage of the own-account population will be performed. An increase in the available data would also allow for more detailed investigations concerning both freight sectors as well as the level of own-account characterization.

One main conclusion that evidently emerges from the research conducted is that local policy-makers should not expect homogeneous responses to the policies implemented. No one-policy-fits-all seems applicable to the LTZ in Rome.

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Bibliographical references


