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# *Heterogeneity in urban freight policy impact: own-account agents in Rome's LTZ*

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Urban freight policy-making aims to improve the efficiency of freight movement in cities. Importantly, contemplated policies impact on complex pre-existent relationships among various agents operating in the distribution chain. The most relevant operators to study are: retailers, transport providers and own-account. There is a lack of knowledge concerning the specificities of these agent-types behaviour that calls for a more detailed analysis at the agent-specific level.
This paper focuses on Urban Freight Transport (UFT) where an agent-specific policy analysis is carried out with specific attention to own account agents. Own account is, in fact, among the least studied agent-types in this context. This lack of attention is mainly due to the difficulty in acquiring data concerning their preferences and also to the widely accepted presumption concerning their relative inefficiency often giving rise to highly penalizing policies specifically aimed at this group.
The empirical results reported are derived from a study conducted in the limited traffic zone (LTZ) in Rome's city centre in 2009. The analysis is based on a highly detailed and representative data set. This include both general information on the specific respondent involved along with company characteristics as well as stated ranking exercises (SRE) where interviewees are presented with alternative policy scenarios and asked to rank them according to their preference structure. The paper reports on the specific preference structure for own account operators. The paper proposes a systematic comparison, via WTP/WTA measures, between the potentially inaccurate estimates deriving from a simplistic analysis of preferences and those originating from an advanced treatment of preference heterogeneity. These considerations are prodromal to potentially distorted policy forecasts that, in turn, would be fed into micro simulation models to evaluate policy impacts.

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Various forms of heterogeneity are explored. The data allow the analysis, among other socio-economic characteristics, of the impact that belonging to specific macro-freight-sectors has on the attributes used in the SRE. Furthermore, adopting a latent class (LC) specification, we test for the presence of respondent clusters in evaluating the policy mix considered for implementation.
The paper addresses methodologically innovative issues; uses a new, detailed and significant data set; discusses a policy relevant issue and produces useful information from a policy-making perspective. The quantification of WTP and WTA measures for possible policies to be implemented provides an important benchmark both for policy makers as well as for researchers in this sector.

Keywords: freight operators; own-account; preference heterogeneity, limited traffic zone.

## 1. **Introduction**

Urban freight policy-making aims to improve freight movement efficiency. Policies impact on complex pre-existent relationships among various agents operating along the distribution chain. Among these, the most relevant are: retailers, transport providers and own-account. A thorough understanding of the specificities of each of these agents' needs, concerns and preferences is rarely analysed in current research. This is mainly attributable to the lack of appropriate data notwithstanding the widely recognized need to analyse the potentially diversified policy effects. These considerations assume a particular interest when considering the intricate and interrelated environment within which the three agents are operating. In other words, there is a need for more detailed analysis at the agent-specific level. Notably, policy implementation may produce undesired results when behavioural and contextual aspects are not explicitly considered in freight transport in general and in urban freight transport (UFT) in particular. There seems to be no one-size-fits-all policy readily available for implementation (Stathopoulos et al. 2012).

This paper focuses on UFT agent-specific policy analysis, in general, and contributes to filling a knowledge gap by studying own account agents, in particular, which are among the least studied agents involved in UFT. This lack of attention to this particular agent-type is mainly due to the difficulty in acquiring data concerning their preferences and also to the widely accepted presumption concerning their relative inefficiency often giving rise to penalizing policies specifically aimed at this category. In other words, if the number of this specific agent-type has to be reduced, usually based on un-tested presumptions, why bother studying it? Recent research conducted in Italy (Danielis et al., 2010) shows that the alleged lower efficiency of own account transport is not always supported by empirical evidence and, even when this is the case, the overall situation is highly diversified among specific freight sectors and supply chains. In other words, policymakers cannot intervene with simple and rough instruments expecting homogeneous impacts and responses. The results of the study reported testify to the presence of relevant heterogeneity among own account operators and consequently underlines the potentially biased estimates that could ensue from a simplistic study of own account preferences.

The empirical results reported are derived from a study conducted in the limited traffic zone (LTZ) in Rome's city centre. The analysis is based on a highly detailed and representative data set collecting a wide range of information including both general information on the specific respondent involved and his/her company's characteristics as well as stated ranking exercises (SRE) where interviewees are presented with alternative policy scenarios. Drawing on the data collected, the paper reports on the differentiated preference structure for own account operators. A systematic comparison is performed, via willingness to pay (WTP)/ willingness to accept (WTA), between the potentially distorted scenario evaluations deriving from the adoption of a simplified and generic analysis of preferences for own account operators taken together and an advanced accounting for preference heterogeneity. This allows us to comment on the potentially distorted policy forecasts that would be fed into micro simulation models to evaluate policy impacts.

Various forms of heterogeneity are explored and tested in this paper. The most fundamental and relevant pertains to the attributes included in the utility function of the agents considered. In particular, drawing on previous evidence (Stathopoulos et al. 2011) we assume that the time-windows attribute has a relevant impact only in own-account agents' utility functions. The data collected allow us to analyse, among other characteristics, the impact that belonging to specific macro-freight-sectors has on the attributes used in the policy rankings. Furthermore, adopting a latent class (LC) specification, we test, for each member-type, for the presence of unobserved classes in responding to the policy mix considered for implementation, again underlining the bias in estimates when adopting simplistic model specifications.

The paper is structured as follows. Section 2 reports a brief overview of the relevant literature concerning agent-type analysis for urban freight transport (UFT). Section 3 describes the study context while section 4 reports on the development of the survey instrument and describes data. The econometric results are reported in section 5, while section 6 concludes.

## 2. Literature review

Aggregate models are typically used when modelling freight. Little attention is usually paid to the critical role that individual actors play in the decision making process. This section reports and discusses recent findings drawn from an increasingly behavioural approach to UFT. In particular, Hensher and Figliozzi (2007) convincingly argue that standard approaches do not account for the complexity of freight movements at different geographical scales thus missing potentially relevant motivations for current scenarios. Behavioural models, a sub-set of disaggregate models explicitly consider stakeholders' utility maximization efforts. One has to identify key decision makers to develop a modelling framework adopting an agent-based micro-simulation approach capable of describing and forecasting the behaviour of the specific actors involved (Liedtke and Schepperle, 2004). Several authors (Gray, 1982; Wisetjindawat et al., 2005; de Jong and Ben-Akiva, 2007; Hensher and Figliozzi, 2007; Samimi et al., 2009; Yang et al., 2009; Roorda et al., 2010) believe UFT is one of the most appropriate fields to develop agent-based micro models.

Policy changes influencing fuel prices, land use patterns and pricing strategies might alter the relative convenience of different UFT options. Puckett and Greaves (2009) argue that it is important to consider jointly both the instruments available to policy makers and the set of attributes influencing freight behaviour to understand the potential impacts that any policy might produce in terms of market outcomes. This is exactly what policy makers like to know *ex-ante* before implementing a given policy. It is important to identify incentives/disincentives with a relevant impact and quantify their bearing on the reference scenario before applying them in a real-life context. To do so one has to pinpoint the type of decision makers involved, discover under which constraints they operate, understand how they interact, and figure out on which set of freight service attributes they finally negotiate. This paper focuses on the role and preference of own account operators, which in the context we study, plays a relevant role (Danielis et al. 2011).

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

The results reported in this paper draws on between March to December 2009 for Volvo Research Foundation in cooperation with Centro Trasporti e Logistica (CTL) of Sapienza University in

Rome and, subsequently, expanded thanks to a MIUR 2008PRIN project. The formal institution of a Limited Traffic Zone (LTZ) in Rome's historical centre dates back to the late eighties. A $5km^2$ area was originally restricted to non-resident vehicles where the bans on traffic now apply both to passenger and freight vehicles. A specific legislation characterizes the $4km^2$ LTZ area in the historical centre where only Euro 1 and later vehicles are allowed to enter with free access awarded only to residents while others (e.g. retailers and freight carriers) pay an access fee. The scheme, enforced by cameras and optical character recognition software, operates during daytime and the yearly permit costs 565 € per number plate. Specific time window regulations, especially aimed at own account operators, apply for access and parking of freight vehicles. Nonetheless, a wide range of exemptions applies to third party freight operators[3].
Indeed, the regulation is essentially designed to foster the use of third account operations while discouraging lengthy parking of own account vehicles given the shortage of on-street parking. Time windows are, alas, not systematically enforced.

## 4. **Development of the survey instrument**

Receivers, carriers and forwarders are, traditionally, considered essential stakeholders in UFT system analysis (Ogden, 1992). The survey concentrate on studying three main supply chain agents: carriers, retailers and own account operators. The first two are well identified in the literature while stakeholder consultations carried out by the authors suggest considering own account operators as well (Stathopoulos et al., 2011). First of all, one has to define, select, develop and customize the attributes to include in the SRE. We report the evolution from stakeholder consultation to attribute definition while highlighting and motivating which specific attributes were included in the final questionnaire design. Indeed, the level of joint policy ex-ante acceptability was the main criterion for attribute inclusion. Subsequently, we describe how each attribute was defined, structured in levels and ranges and progressively differentiated by agent type to account for real-world agent-type specific constraints and preferences. The attribute selection drew on results deriving from previous stakeholder surveys. The following sections overview the attributes included, describe their characterization and motivates our following steps.

### *4.1. Attributes included in the Stated Ranking Exercise*

Each alternative in the SRE is described by a set of attributes that can take several levels to describe ranges of variation when the alternatives are presented to the respondents. The attributes used were derived from three main sources, namely; a) literature survey; b) previous quantitative studies on city freight distribution in Rome; c) focus group meetings with relevant expert stakeholders. We conducted an extensive review of the current literature on *city logistics* with an agent-based perspective with the intent of identifying a set of potentially conflicting policy components when viewed from each of the different agent-type perspectives[4].
Reviewing previous quantitative studies on city logistics in Rome (STA, 2001; Filippi and Campagna, 2008) and considering the expert stakeholder surveys helped selecting the attributes

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[3] A synthetic summary of the regulatory regime in place is reported in the Appendix.
4 Nighttime deliveries, for instance, were considered efficiency enhancing by carriers but reputed a mere increase in costs by retailers.

for the SRE[5]. We selected attributes with a high level of shared support with the belief that this would facilitate the introduction and persistence of a given policy (Stathopoulos et al., 2011). The attributes that finally underwent pilot testing with real operators, were: 1) number of l/u bays; 2) probability to find l/u bays free; 3) time windows; 4) exemption from time windows; 5) entrance fees; 6) exemptions from entrance fees (Stathopoulos et al., 2011). Each of these six attributes has been on the political agenda for a long period and all were perceived as realistic measures to include in future policy mixes (Marcucci et al., forthcoming).

### *4.2. Agent-type differentiations*

SRE respondent-type differentiations were adopted after piloting with operators. The main agent-type diversification is the inclusion of the time window (TW) attribute only for own account operators due to an anchoring affect around the SQ condition. Indeed, only own account operators are *de facto* facing TW restrictions since carriers, operating as third account, can access the LTZ at all times. The SRE choice set consisted of three policy options always including the SQ alternative. Agents were asked to rank policy bundles according to their preferences. Table 1 reports an example of a SRE task.

*Table 1 - Example of a ranking task*

| | **Policy 1** | **Policy 2** | **Status Quo** |
|---|---|---|---|
| Loading/Unloading bays | 400 | 800 | 400 |
| Probability to find L/U bays free | 20% | 10% | 10% |
| Entrance fee | 1000 € | 200 € | 600 € |
| Time windows open | 20:00-10:00/ 14:00-16:00 | 04:00/ 20:00 | 20:00-10:00/ 14:00-16:00 |
| Policy ranking | | | |

The levels characterizing the attributes should, ideally, be plausible, policy relevant and possible to implement although a choice experiment may also test currently unavailable options (e.g. a new mobility control policy). The attributes, levels, distribution and range are illustrated in Table 2.

*Table 2 - Attribute levels and ranges used in the SRE*

| **Attribute** | **Number of levels** | **Level and range of attribute (Status Quo underscored)** |
|---|---|---|
| Loading/unloading bays: | 3 | <u>400,</u> 800, 1200 |
| Probability of free l/u bays: | 3 | <u>10%</u>, 20%, 30% |
| Time windows: | 3 | OPEN from 18:00 to 08:00 e from 14:00 to 16:00; <u>OPEN from 20:00 to 10:00 e from 14:00 to</u> |

5 An important phase of the expert surveys focused on defining the policies considered most appropriate to mitigate the identified UFT problems (Stathopoulos et al., 2011). Volvo Report (2010) provides a detailed overview of the link between the stakeholder survey results and the attributes used in the SRE.

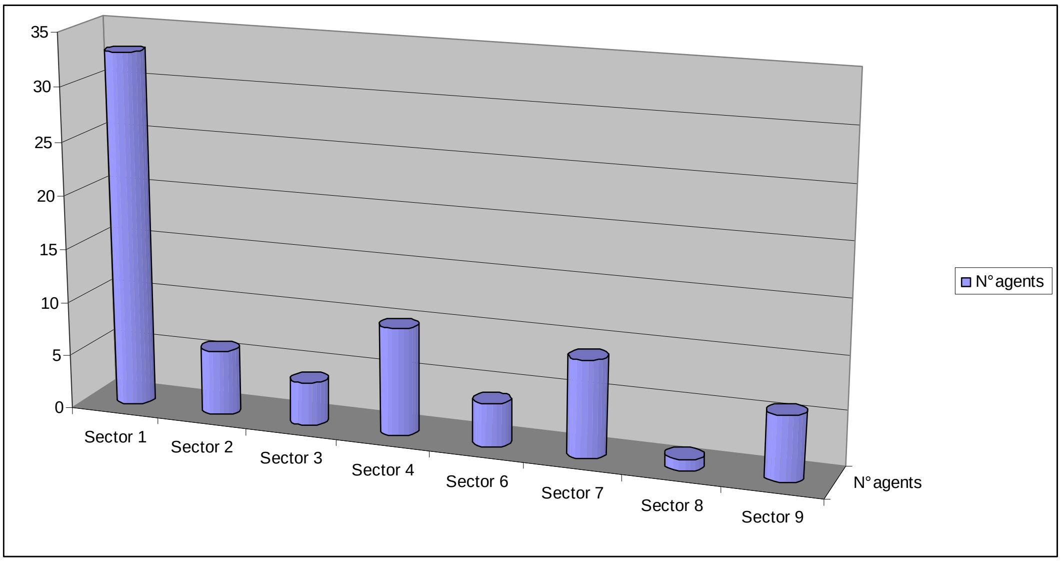
| | | |
|---|---|---|
| | | 16:00;<br>OPEN from 04:00 to 20:00 |
| Fees: | 5 | 200€, 400€, 600€, 800€, 1000€ |

All attributes are characterized by at least three levels. This allows testing for potential non-linear effects that are of great importance in particular when evaluating policy reactions since there might be differentiated effects deriving from specific levels.

### *4.3. Data description*

The case study reported is part of a larger study partially financed by Volvo research foundation and MIUR concerning UFT policy definition and implementation.
The total number of interviews performed was 252 but only 229 were used since pilot interviews were discarded form final elaborations. Our sample consists of 73 own account, 90 retailers and 66 transport providers.
More in detail, we report the distribution of the 73 own account operators interviewed in 9 main macro freight sectors used in model estimation[6] (Figure 3).

*Figure 3: Own-account agent distribution by main freight sector*




Note: The macro sectors reported are the following: 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*

[6] No operators belonging to sector 5 was interviewed and only one belonging to sector 8.

*accessories* (e.g. vehicle components, vehicles, 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).

## 5. **Econometric results**

In this section we report the results, for own-account alone, of the models estimated using the data elicited via the SRE previously described. The reference model (M1) presents all attributes as linear and normalized to present the real measurement scale of the attribute. Further specifications report refinements with the intent of emphasizing the potential biases implicitly deriving from a simplified treatment of heterogeneity within the members belonging to this agent-type category[7].

The estimation of a model 1 (M1), reported in Table 3, utilising just normalized variables provides no interesting results[8]. In fact, the statistically significant negative impact of loading and unloading bays (LB) on utility, when dealing with a linear variable passing from lower to a higher one is counter intuitive. The entrance fee (T) attribute has a significant coefficient with the expected sign. Effects coding of the variables is introduced in a subsequent specification of the model (M2) for two reasons. First, we would like to test for the presence of relevant non-linearities in passing from one level to another given the discrete nature of variation of the levels of the attributes used. Second, effects coding avoids confounding the effect of the reference level with the overall mean of the estimated parameters at the cost of constraining their sum to be 0[9]. We report the results of a parsimonious model (M2) with effects coded variables and the number of levels

7 Not even considering different utility specifications for each of the three member types considered would induce even greater biases. Due to lack of space we do not address this issue even if we are working on a companion paper specifically addressing this issue.

8 A base model with an alternative specific constant fort the status quo was estimated and no particular difference was detected when compared to the model reported.

9 On this, and more general estimation issues, please refer to Marcucci E., (2011) Scelte di trasporto e modelli a scelta discreta, Franco Angeli, Milano.

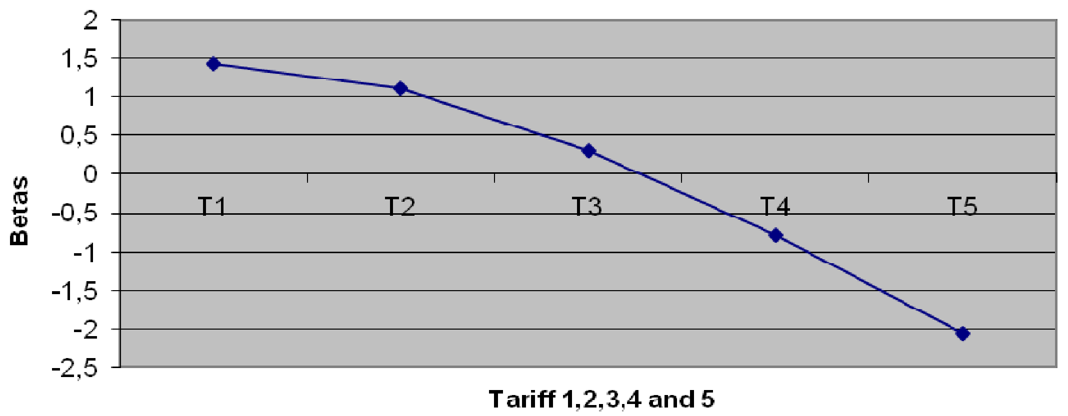
*Table 3: Model estimates for M1- M5 10*

| M1 | | M2 | | M3 | | M4 | | M5 C1 | | C2 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Var | Coeff | Var | Coeff | Var | Coeff | Var | Coeff | Var | Coeff | Var | Coeff |
| LB | -0,205 | LB2 | 0,042 | LB23 | 0,083 | LB23 | 0,079 | LB23 | 0,609 | LB23 | -0,018 |
| | -4,289 | | 0,601 | | 0,452 | | 0,273 | | 1,814 | | -0,089 |
| P | -0,021 | LB3 | 0,103 | P23 | 0,425 | P23 | 0,417 | P23 | 0,663 | P23 | 0,395 |
| | -0,468 | | 1,444 | | 3,938 | | 2,883 | | 2,952 | | 3,651 |
| T | -0,516 | P2 | 0,282 | T1 | 1,496 | T1 | 1,622 | T1 | 1,944 | T1 | 1,747 |
| | -12,257 | | 2,952 | | 12,006 | | 10,501 | | 7,712 | | 15,846 |
| TW | 0,354 | P3 | 0,061 | T2 | 1,119 | T2 | 1,101 | T2 | 1,950 | T2 | 1,128 |
| | 6,999 | | 0,837 | | 18,077 | | 6,119 | | 0,872 | | 8,088 |
| | | T1 | 1,399 | T3 | 0,344 | T3 | 0,442 | T3 | 0,454 | T3 | 0,141 |
| | | | 11,494 | | 2,786 | | 2,112 | | 2,018 | | 0,884 |
| | | T2 | 1,124 | T4 | -0,798 | T4 | -0,905 | T4 | -1,232 | T4 | -0,902 |
| | | | 11,080 | | -6,785 | | -5,510 | | -5,546 | | -8,186 |
| | | T3 | 0,318 | T5 | -2,127 | T5 | -2,258 | T5 | -3,116 | T5 | -2,115 |
| | | | 3,524 | | -11,676 | | -9,709 | | -8,909 | | -11,313 |
| | | T4 | -0,870 | TW1 | -1,270 | TW1 | -1,326 | TW1 | -3,153 | TW1 | -0,280 |
| | | | -6,778 | | -11,831 | | -17,653 | | -10,665 | | -2,713 |
| | | T5 | -1,970 | TW0 | 0,023 | TW0 | 0,036 | TW0 | 0,303 | TW0 | -0,115 |
| | | | -10,345 | | 0,257 | | 0,361 | | 1,583 | | -1,206 |
| | | TW1 | -0,933 | TW2 | 0,744 | TW2 | 1,287 | TW2 | 0,395 | TW2 | 0,395 |
| | | | -11,271 | | 6,984 | | 10,887 | | 0,560 | | 0,560 |
| | | TW0 | 0,039 | LB23S1 | 0,318 | LB23S1 | 0,364 | LB23S1 | -0,224 | LB23S1 | 0,518 |
| | | | 0,606 | | 1,520 | | 1,299 | | -0,567 | | 2,265 |
| | | TW2 | 0,556 | LB23S2 | 0,320 | LB23S2 | 0,326 | LB23S2 | 0,223 | LB23S2 | 0,203 |
| | | | 8,940 | | 0,823 | | 0,584 | | 0,309 | | 0,393 |
| | | | | LB23S3 | -0,473 | LB23S3 | -0,537 | LB23S3 | -0,728 | LB23S3 | -0,170 |
| | | | | | -0,968 | | -0,590 | | -0,456 | | -0,373 |
| | | | | LB23S7 | 0,320 | LB23S7 | 0,396 | LB23S7 | 1,062 | LB23S7 | 0,102 |
| | | | | | 0,962 | | 0,944 | | 1,596 | | 0,260 |
| | | | | P23S7 | 0,527 | P23S7 | 0,521 | P23S7 | 0,810 | P23S7 | 0,505 |
| | | | | | 1,837 | | 0,967 | | 1,393 | | 1,581 |
| | | | | T1S7 | -0,268 | T1S7 | -0,263 | T1S7 | -0,649 | T1S7 | -0,045 |
| | | | | | -1,214 | | -0,691 | | -1,441 | | -0,154 |
| | | | | T2S1 | 0,144 | T2S1 | 0,204 | T2S1 | -0,117 | T2S1 | 0,181 |
| | | | | | 1,096 | | 1,047 | | -0,450 | | 1,153 |
| | | | | T2S2 | 0,410 | T2S2 | 0,496 | T2S2 | 0,368 | T2S2 | 0,330 |
| | | | | | 1,315 | | 0,054 | | 0,557 | | 0,941 |
| | | | | T4S2 | -0,537 | T4S2 | -0,612 | T4S2 | -0,710 | T4S2 | -0,583 |
| | | | | | -1,615 | | -0,193 | | -1,117 | | -1,516 |
| | | | | TW1S2 | 0,485 | TW1S2 | 0,525 | TW1S2 | 0,643 | TW1S2 | 0,633 |
| | | | | | 2,641 | | 0,205 | | 1,720 | | 2,186 |
| | | | | TW1S3 | 1,153 | TW1S3 | 1,234 | TW1S3 | 1,614 | TW1S3 | 0,569 |
| | | | | | 4,307 | | 2,789 | | 1,987 | | 2,415 |
| | | | | TW1S7 | 0,245 | TW1S7 | 0,243 | TW1S7 | 0,197 | TW1S7 | 0,204 |
| | | | | | 1,516 | | 0,883 | | 0,569 | | 1,120 |
| | | | | TW2S1 | -0,584 | TW2S1 | -0,600 | TW2S1 | -1,522 | TW2S1 | 0,213 |
| | | | | | -2,366 | | -3,499 | | -3,050 | | 0,903 |
| | | | | TW2S2 | -1,361 | TW2S2 | -1,526 | TW2S2 | -1,623 | TW2S2 | -1,223 |
| | | | | | -3,322 | | -0,165 | | -1,955 | | -2,920 |
| | | | | TW2S7 | -0,765 | TW2S7 | -0,872 | TW2S7 | -0,925 | TW2S7 | -0,867 |
| | | | | | -2,189 | | -2,260 | | -1,179 | | -2,501 |
| | | | | | | dev latent RE | | | | Prob LC | |
| | | | | | | E01 | 0,391 | | | PC1 | 0,472 |
| | | | | | | | 1,589 | | | | 1,545 |
| | | | | | | E02 | 0,449 | | | PC2 | 0,528 |
| | | | | | | | 1,969 | | | | 1,909 |
| | | | | | | E03 | 0,776 | | | | |
| | | | | | | | 2,573 | | | | |
| LL | -1062 | | -964 | | -937 | | -922,42 | | -822 | | |
| Par | 4 | | 10 | | 23 | | 26 | | 47 | | |
| N. obs | 1270 | | | | | | | | | | |

[10] To facilitate the interpretation of variables and results, rather than explaining the meaning of each variable we report the logic adopted in assigning the labels. The basic attributes are loading and unloading bays (LB), probability of finding the free (P), access tariff (T) and time windows (TW). The levels of the attributes are reported next, thus LB2 represent the second level of the loading bays attribute and LB23 the second and third level. When reporting sector specific results we indicate the sector last. LB23S2 thus signifies the coefficient of the loading and loading bay attribute for both the second and third level for the second freight sector. All the models reported passed a log likelihood ratio test when comparing a restricted versus unrestricted model test. Detailed results are not reported to space limitations but are available from Authors upon request.

reduced only to the significant ones[11]. Looking at time window sensitivity there is a notably larger negative coefficient associated with the most unfavourable condition while obtaining the more favourable time window yields less utility. This indicates an asymmetry in preferences where own account operators are generally more reluctant to accept deteriorated conditions than they are interested in obtaining improvements. Considering the entrance fare each of the coefficients are both statistically significant and different from one another thus indicating a differentiated response to equally distanced level of variation. This can be observed in Figure 4.

Figure 4*: M2 – Non-linearity of the impact of the different tariff levels*




After various attempts of reconciling parsimony and detail in explanation, other explanatory variables pertaining to the specific freight sector considered were introduced in M3. Several of the different sectors of operation appear to have a statistically relevant impact on sensitivities: P which on average has, for the second and third level of the variable, a mean positive impact of 0,425 instead increases to 1,052 for operators in the garment sector (S7)[12]. Considering TW1, a more restrictive level with reference to the status quo, that, on average, has a negative impact of -1,270 whereas for S2 is equal to -0,785 and -0,117 for S3 and -1,025 for S7. Given the heterogeneous impact of the variable on the overall choice probability it should be expected that a given policy will provoke a differentiated reaction in the 3 sectors with respect to the average response. Similar effects are detectable for a more accommodating TW level (TW2) for S1, S2 and S7. The average 0,744 positive impact drops to 0,160 for S1 and becomes non perceptible for S2 and S7. These considerations suggest great attention when evaluating sector impacts of one-size-fits-all time windows policy.

We also test for the presence of latent factors explaining heterogeneity in preferences by estimating an error component specification that also accounts for the panel structure of the data employed (M4). The model testifies for the presence of such latent constructs that explain heterogeneity in preferences due to correlation among utilities across repeated alternatives. The model fit improves substantially over the previous specifications; no evident

[11] The level 2 (400) and 3 (800) for the loading bays attribute (LB) were considered as having the same impact on choice given the first results in estimating M1. Consequently we created a new variable denominated LB23 comprising both cases. The same was done for the probability (P) of finding the LB free thus creating the new variable P23.

[12] It is important to recall that the variables are effects coded and in order to interpret the coefficients correctly one has to add the value of the base variable (e.g. P23 = 0,425) to that of the sector influence (e.g. P23S7 = 0,527) to obtain the final value of the impact the variable has on utility (1,052).

differences are detected in the non-linear effects for the T attribute (comparison not reported) while the TW attribute shows a statistical difference (given an overall non-linear effect) in how own-account agents evaluate potential deterioration of the TW attribute. The effect, of a restriction in the TW attribute is in fact larger than in M2 compared to the same estimated value in M3 and M4.

The same specification used for (M4) is employed to search for heterogeneity in the attribute coefficients by using a discrete mixing model (Latent Class –LC–) (M5) where we assume that individual behaviour depends on observable attributes and on latent heterogeneity that varies with factors that are unobserved by the analyst. Heterogeneity is introduced by different class probabilities and analysed through a model of discrete parameter variation assuming that individuals are implicitly sorted into a set of classes but where the analyst knows not which individual belongs to which class. The best results are obtained with a 2-class specification. Looking at the results obtained with this better fitting model one realizes that, with an almost proportional and statistically significant probability of belonging to one of the two classes, the impact of a restrictive time window policy that were very similar for M3 and M4 and not too different for M2, *de facto*, should be interpreted as an average of two quite distinct values (-3,153 for class 1 and -0,28 for class 2). Instead the views of improved time windows converges for the two classes (equal to 0,395). Similar considerations under this respect can be drawn concerning a potential increase (T4 and T5) in the level of the tariff charged for entering the LTZ from the current level. In fact, the impact of T4 and T5 on utility is, on average, respectively equal to -0,858 and -2,119 in M2, M3 and M4. These values may however mask an underlying difference in the perceptions of an increase from the fourth to the highest value. In particular, in the first class of respondents, the disutility increases from -1,2 to -3,1 for the highest fee, compared to a disutility increasing from -0,9 to -2,1 in the second. From these considerations one can infer that the first class has a considerably greater sensitivity to tariff increases and time windows restrictions compared to the second.

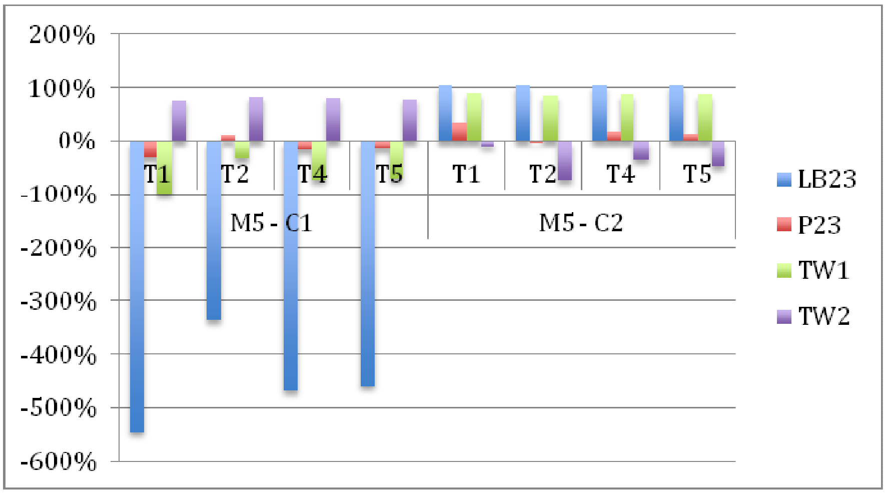
Notwithstanding the interesting analysis just discussed, an informative comparison among the different estimates produced in the different models reported need to be performed to circumvent the possible differences in scale across models. Willingness to pay (WTP) and willingness to accept (WTA) measures are used to pursue this objective. It is important to clarify that it is our intention to preserve the richness of the results obtained in terms of non-linearity discovered in passing from one attribute level to the other. These considerations are particularly important for T (5 levels – 4 variations) and TW (3 levels – 2 variations). It is important to clarify that since we have only ameliorative variations, with respect to the *status quo* level, for both LB and P in the case of reductions of T levels, in order to interpret the meaning of the coefficients one has to imagine that the value derived represents (in order to have a trade off of some sort) the amount of money the agent would be willing to receive for not having potentially benefited from the increase in the level of the beneficial attribute under consideration.

*Table 4 – WTP and WTA for M3, M4, M5C1 and M5C2*

| | M3 | | | | M4 | | | | M5 - C1 | | | | M5 - C2 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | T1 | T2 | T4 | T5 | T1 | T2 | T4 | T5 | T1 | T2 | T4 | T5 | T1 | T2 | T4 | T5 |
| LB23 | -11 | -15 | 21 | 8 | -10 | -14 | 17 | 7 | -63 | -62 | 99 | 39 | 2 | 3 | -4 | -2 |
| P23 | -57 | -76 | 107 | 40 | -51 | -76 | 92 | 37 | -68 | -68 | 108 | 43 | -45 | -70 | 88 | 37 |
| TW1 | 170 | 227 | -318 | -119 | 164 | 241 | -293 | -117 | 324 | 323 | -512 | -202 | 32 | 50 | -62 | -26 |
| TW2 | -100 | -133 | 187 | 70 | -172 | -230 | 322 | 121 | -41 | -40 | 64 | 25 | -45 | -70 | 88 | 37 |

The analysis of table 4 is very useful for identifying both the most relevant attributes for the agents interviewed as well as the potential biases induced by an inadequate treatment of the heterogeneity in the attributes considered and the non linear effect in passing from one tariff level to another. In fact, in M3 the WTP for an extra 200 LB when starting from a tariff of 600€ and increasing it to 800€ is 21€ per year whereas this drops to 8€ per year if the starting tariff is 800€ and is raised to 1.000€.  On the other hand, using M3 estimates, would need a compensation of 15€ for not receiving a potential increase of 200 LB when the tariff is reduced from 600€ to 400€ while it is 11€ when the starting tariff is 400€ and is reduced to 200€. Analogous considerations can be performed for all the other attributes and model specifications. Analysing the results reported indicates that there are some important variations in estimates according to which model specification is used but, on the other hand, there are also some stable indications. In particular, it is quite clear that TW are, in general, valued more than LB and P. Moreover, restrictive measures (TW1) have, in general, a greater impact than accommodating ones (TW2). These results are in line with previous results obtained with the same dataset. For the purpose of the present analysis it is worthwhile comparing the different over or under estimations for each attribute and level considered depending on the given model specification used. In so doing we compare the results obtained with the best fitting model estimated (LC with 2 classes) and the other models. With the intent of facilitating the comparison we report below the percentage variations alone. To focus the comparison we illustrate only the percentage WTP variations between M4 and M5.

*Figure 5: Percentage variations in WTP and WTA between M4 and M5*




Analysing the figure above it is clear that the presence of two latent classes has quite relevant implications in general with respect to the average values of M4 but this is much more pronounced with reference to the LB attribute and less so for P. Notwithstanding the relative biases among the models reported and their implications in terms of policy definition, the magnitude of the WTP/WTA indicates that the most important attributes are TW1, TW2 and P. These considerations are crucial in devising intervention policies since the only infrastructural variable (LB) seems to play a relatively minor role thus suggesting that local policy makers have relatively inexpensive but powerful ways to intervene to influence own –account operators' behaviour. The results reported show how important and potentially valuable a small investment in applied research can be. Knowledge about specific characteristics helps devising appropriate and focused policies to achieve the desired objectives.

## 6. Summary, conclusions and future research

This paper has reported the results of a stated ranking exercise performed within Rome's LTZ own-account operators. The main objective of the paper is to underline the role that an appropriate treatment of heterogeneity might have in defining UFT policies and the need to develop sector specific analysis and policies. Local policy makers tend to intervene, for various reasons, with policies that assume homogeneity in reactions to the policy implemented. On the contrary the analysis performed on our data shows that there is relevant heterogeneity in agents preferences not only among the different agent-type considered but also within a single specific category (own-account). Several indications point towards the fact that we should expect differentiated responses to one single policy both in terms of latent classes (M5) as well as in terms of the freight sector involved (M3 and M4).

As for future research we are going to work on 2 companion papers adopting a similar approach but dealing with different agent-type, namely: transport providers and retailers. Subsequently we would like to develop a behaviourally more sophisticated model were we analytically model, following the approach developed in Sydney by Hensher and Puckett in this field, the interaction process whereby we study on which policy intervention two agent-types are going to converge if asked to express a preference.

UFT is surely an interesting field of research, especially when considering the strategic role city and city development play in fostering economic growth, but also a daunting one given all the complex and interrelated economic relations characterising it. However, if one thing has clearly emerged from our research is that ignorance of agents' preferences in UFT is *not* bliss.

## 7. Bibliographical references


Danielis, R., E. Maggi, L. Rotaris, and E. Valeri (2011), "La logistica urbana delle merci a Roma" in XXXII Conferenza italiana di Scienze regionali, conference proceedings, www.aisre.it.

Danielis, R., Rotaris, L., Marcucci, E. (2010) "Urban freight policies and distribution channels: a discussion based on evidence from Italian cities", European Transport/Trasporti Europei 46: 114 - 146.

de Jong, G., Ben-Akiva, M., (2007) "A micro-simulation model of shipment size and transport chain choice" Transportation Research Part B, 41, 950-965.

Filippi, F., Campagna, A., (2008). Indagine sulla distribuzione delle merci a Roma, nell'ambito dello Studio di settore della mobilità delle merci a Roma. CTL: Centre for studies on Transport and Logistics and ATAC: Agency of mobility of Rome's municipality.

Gray, R. (1982), "Behavioural Approaches to Freight Transport Modal Choice", Transport Reviews, 2(2), pp. 161-184.

Hensher, D.A., Figliozzi, M.A., (2007) "Behavioural insights into the modelling in freight transportation and distribution system – guest editorial" Transportation Research Part B, 41, 921–923.

Liedtke, G., and H. Schepperle (2004) Segmentation of the Transportation Market with Regard to Activity–based Freight Transport Modelling, International Journal of Logistics: Research and Applications, Vol. 7, No. 3, pp. 199-218

Marcucci E., (2011) Scelte di trasporto e modelli a scelta discreta, Franco Angeli, Milano.

Marcucci E., Gatta V., Stathopoulos A., Valeri E., (forthcoming), "Analysing Interaction in Urban Freight Distribution: the case of Rome", Marcucci E., (Guest editor), "Stated Preference Methods for Transport Choice Analysis", Italian Journal of Regional Science Association.

Ogden, K.W., 1992. Urban goods movement: a guide to policy and planning. Ashgate, Aldershot, UK.

Puckett, S. M., and Greaves, S. (2009). "Estimating Policy-Induced Changes in Freight Vehicle Emissions in Sydney." Institute of Transport and Logistics Studies Working Paper, The University of Sydney.

Roorda, M.J., Cavalcante, R., McCabe, S., Kwan, H., 2010. A conceptual framework for agent-based modelling of logistics services. Transportation Research Part E: Logistics and Transportation Review 46, 18-31.

Samimi, A., A. Mohammadian, and K. Kawamura (2009) Integrating supply chain management concept in a goods movement microsimulation. IEEE International Conference on Service Operations, Logistics and Informatics, July 22 - 24, 2009, Chicago, IL, USA

STA. (2001). "Quadro conoscitivo del problema della distribuzione delle merci nel Centro Storico di Roma." Rome.

Stathopoulos A., Valeri V., and E. Marcucci (2012), "Stakeholder reactions to urban freight policy innovation", Journal of Transport Geography, 22, pp. 34-45.

Stathopoulos A., Marcucci E., Valeri E., Gatta V., Nuzzolo A., Comi A., (2011), "Urban Freight Policy Innovation for Rome's LTZ: A Stakeholder Prospective", in City Distribution And Urban Freight Transport: Multiple Perspectives, eds. Cathy Macharis , Sandra Melo, Edward Elgar Publishing Limited, Cheltenham, pp. 75-100.

VOLVO REPORT - (2010), Innovative solutions to freight distribution in the complex large urban area of Rome, Final report, project SP-2007-50. mimeo

Wisetjindawat, W., Sano, K., Matsumoto, S., 2006. Commodity Distribution Model Incorporating Spatial Interactions for Urban Freight Movement. Transportation Research Record: Journal of the Transportation Research Board 1966, 41-50.

Yang, C. H., J. Y. J. Chow, and A. C. Regan (2009) State-of-the Art of Freight Forecasting Modeling: Lessons Learned and the Road Ahead. Proceedings, 88th Annual Meeting of the Transportation Research Board, Washington DC, 11–15 January 2009.