DISCUSSION PAPER SERIES

IZA DP No. 4035

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February 2009

Forschungsinstitut
zur Zukunft der Arbeit
Institute for the Study
of Labor

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IZA Discussion Paper No. 4035
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ABSTRACT

Forecasting Errors: Yet More Problems for Identification?*

Forecasting errors pose a serious problem of identification, often neglected in empirical applications. Any attempt of estimating choice models under uncertainty may lead to severely biased results in the presence of forecasting errors even when individual expectations on future events are observed together with the standard outcome variables.

JEL Classification: C01, C51

Keywords: identification, forecasting errors, subjective probabilities

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* I am indebted to C. Manski for his comments and encouragement in the course of a long conversation. A preliminary version of this paper was written while visiting U.C. Berkeley, kindly hosted by D. Card and the Institute for Research in Labor Economics. The usual disclaimer applies: errors are only mine.

Forecasting errors pose a serious problem of identification, often neglected in empirical applications. Any attempt of estimating choice models under uncertainty and of the relevant structural parameters may lead to severely biased results in the presence of forecasting errors even when individual expectations on future events are observed together with the standard outcome variables. Unfortunately this is almost never the case in microeconometric explorations. C. Manski raised an important point in a series of very authoritative contributions that should have left the mark, but apparently received little attention by practitioners (1999, 2000, 2004). According to Manski (2004) "observed choices may be consistent with many alternative specifications of preferences and expectations, so researchers assume particular sorts of objectively correct (i.e. rational) expectations … This practice reduces the task of empirical inference to revelation of preferences (outcomes) alone, but has contributed to a crisis of credibility". [2]

The aim of this paper is to carry Manski's argument one small step further: even if individual expectations on future events were fully observable, identification may be a problem when people make forecasting errors, i.e. when expectations do not match up with *ex-post* realizations.

More specifically, I show how the identification problem comes about in the presence of agents who incur in forecasting errors, and indicate the conditions that allow the estimation bias to be relatively contained.

The classical problem of job-switching provides a good case: workers who receive an outside offer face the choice of accepting the offer and moving to a different position, or staying on the present job. Once the choice is made, it is irreversible at least in short run. The existence of exit costs from wrong decisions is a crucial element for the argument discussed in this paper.

It is reasonable to assume that workers act on the basis of a preference function U with two arguments: future wage growth and job quality (however measured). Labor economists, once the outcomes of movers' and stayers' decisions are observed, will engage in the estimation of parameters like the marginal rate of substitution between wage growth and job quality.

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[2] The plausibility of rational expectations has, notoriously, been questioned by many. One of them is Manski himself. Serious doubts on the assumption of rational expectations have been cast by Kahnemann and Tverski (1987). According to Pesaran (1987) rational expectations "are based on extreme assumptions and cannot be maintained outside the tranquillity of a long-period steady state".

Assume a very simplified world, with two states of nature: G (good) and B (bad), occurring with probability p and (1-p), and two options, M (move) and S (stay). Outcomes associated with G have a higher payoff than those occurring under B. All workers face the following payoff matrix (tab. 1), identical for all individuals:

Tab. 1

	State of nature = G	State of nature = B
M (move)	U (M,G)	U (M,B)
S (stay)	U (S, G)	U (S, B)
Prob (occurrence)	P	(1 –p)

Agents will choose either M or S, depending on their preference ordering between wage growth and job quality.

Expected utilities are as follows:

$E(M) = U(M,G)\,p + U(M,B)\,(1-p)$

$E(S) = U(S,G)\,p + U(S,B)\,(1-p)$

yielding the following decision rule:

iff $[U(S,B) - U(M,B)] / [U(M,G) - U(S,G)] < p / (1-p)$

then choose M

choose S otherwise

Given the four payoffs, the higher p, the higher the probability that agents will choose M.

In this example the ranking of the four outcomes is irrelevant. It may be assumed that if the “good” state of nature (G) obtains, movers and stayers, having made the optimal choice, will be equally or nearly equally well off, the former attaining higher wage growth at the cost of lower job quality. If “bad” (B) prevails, the conservative stayers will end up on a lower utility curve, dominating nonetheless the movers’ outcome under the same state of nature. Thus it will generally hold

$[U(S,B) - U(M,B)] > [U(M,G) - U(S,G)]$

Identification of the trade-off is at hand if the workers’ choices are observed as well as the probabilities p. But workers do not know p: they will take action on the basis of their subjective expectations on p, say π, using the same decision rule as above, with π in place of p. As above, identification is possible if π are equal to p, or if they are sufficiently close to p.

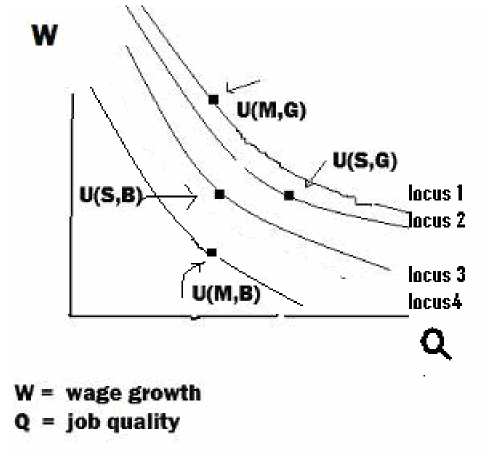

Figure 1 - Four possible outcomes for movers and stayers

In real life, as Manski argues, the *ex-ante* subjective probabilities π are very seldom revealed.

Ex-post, we observe the states of nature, the choice made by each agent (M or S), and the outcome in terms of wage growth and job quality. If agents share similar preferences and G obtains, observations will lie on (or clusters around) loci 1 and 2 (fig. 1). If B obtains, the outcomes will lie on loci 3 and 4. In the first "good" case, identification of the utility parameters may be possible, if the distance between loci 1 and 2 is sufficiently small. In the second "bad" case, identification will generally fail. Choice data alone do not reveal the preferences of agents. They reveal only that preferences and expectations combine to yield the observed outcomes. The same conclusion holds *a fortiori* in the more likely case in which agents' expectations will not be the same.

Suppose Mr. Smith is offered a job at Fiat: excellent if the auto industry does well (state G), terrible if not (state B). Mr. Smith puts a high probability on state G, chooses M accordingly, but he proves wrong as B occurs. So he is stuck at Fiat, with utility U(M, B) < U(M,G). *Ex-post* Mr. Smith may be viewed as an "overconfident risk-taker" who was hit by bad luck. But he may have done the right thing *ex-ante*.

Will the explicit introduction of forecasting errors change the structure of the problem ? Let d be the probability of making the correct forecast, unknown to the players and identical for all. Each will stick to her/his subjective probability π, but the game takes a different form.

The expected utility of choosing each alternative (M or S) will no longer be only a function of π as the outcome now depends also on the individual ability to forecast future events. We know that $U(M,G) > U(M,B)$ and $U(S,G) > U(S,B)$. The agents' most favorable outcomes are those associated with the "good" state of nature and each agent is aiming at such outcomes. But the attainment of, say (M,G), will now occur in two different cases: following the "right" guess for the "good" state of nature (whose probability is πd), but also as a consequence of a "wrong" guess for the "bad" state of nature, occurring with probability $[(1-\pi)(1- d)]$.

Expected utilities of each outcome are expressed as follows:

$E(M,G) = \pi d \, U(M,G) + (1-\pi)(1-d) \, U(M,B)$

$E(M,B) = (1-\pi) d \, U(M,B) + \pi (1-d) \, U(M,G)$

After simplifying, however, the d disappear

$E(M) = E(M,G) + E(M,B) = \pi U(M,G) + (1-\pi) U(M,B)$

$E(S) = E(S,G) + E(S,B) = \pi U(S,G) + (1-\pi) U(S,B)$

and, not surprisingly, the decision rule looks identical as before:

iff $[U(S,B) - U(M,B)] / [U(M,G) - U(S,G)] < \pi / (1 - \pi)$

then choose M

choose S otherwise

which is independent of d, unknown to the agents and completely embodied in their expectations π. If d were known, the decision rule would instead take the form

iff $[U(S,B) - U(M,B)] / [U(M,G) - U(S,G)] < d / (1 - d)$

then choose M

choose S otherwise

Not surprisingly, the larger the probability d of making the correct prediction, the higher the probability that M will be chosen over S. And, of course, the utility differentials will matter as indicated in fig. 1.

Knowledge of the subjective expectations π is no longer sufficient to infer what the choice will be. The d probabilities are "embodied" in the subjective expectations π. Observed outcomes will differ from the optimal"ex-ante" decisions, because

$$\pi / (1 - \pi) \neq d / (1 - d)$$

Some agents will bet on G, and choose M aiming at (M,G), but may end up in (M,B) if B occurs. Alternatively, G may occur when some put their stakes on B, choose S aiming at (S,B), but will end up better off in (S, G). As a consequence, the utility parameters will not be identifiable. A plausible counter-argument is that, if the game is repeated, everything else constant, and learning takes place, π will converge towards d. Unfortunately, repeated games are found only in the textbooks,

Under certain conditions identification will be viable also in the presence of forecasting errors: if the utility differentials among "good" and "bad" outcomes are sufficiently small, the trade-off will re-emerge simply as a consequence of "squeezing" (fig. 2): this simply means that the cost associated to a forecasting error, is indeed small. In a way, it is like taking uncertainty away from the context. Similar situations arise when the choice set is continuous and convex (as in the textbook example of a consumption mix between butter and jam): in such cases the objective functions are often flat at their optimum. Thus agents may be "near optimal" in utility but far from the optimal mix in terms of actions taken. Here too, identification may not be a problem. [3]

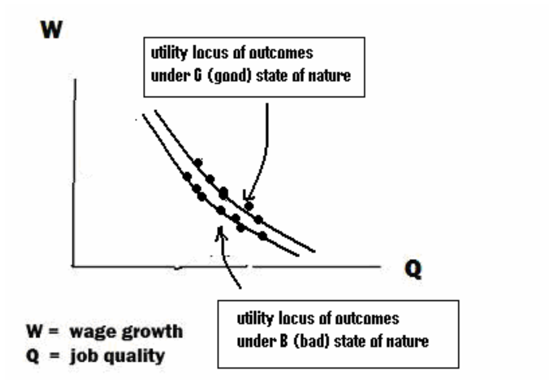

Fig. 2 - "squeezed" utilities allow identification (the graph displays the outcomes with many decision makers holding different payoffs)

In many real-life examples, however, the choice set is discrete and the exit cost from a wrong decision may be high. More often than not economic decisions do not involve marginal factor adjustments, but choices among "big" options that yield large gains or losses depending on

[3] In the simplest textbook examples learning takes place rapidly and decisions can be adjusted, If, for instance, ex-ante expectations on quality and prices prove wrong, individuals will quickly adjust them and shift to the optimal bundle, without incurring in exit costs. Thus repeated observations of this kind of individual decisions will not display the pattern that precludes identification.

the states of nature [4]: organizational styles, physical irreversible investments, large financial operations, mergers and acquisitions, crucial individual decisions on working careers and family lifestyles. Similar features denote the decisions of a government or a social planner (à la Arrow) in the field of social welfare, urban development, educational policy, etc. where final outcomes are observable at the end of long run processes, and the environment is characterized by uncertainty. Likewise for agencies or judicial courts invested with "tragic choices" (à la G. Calabresi). [5]

Manski has strongly advocated the collection of data on expectations and their use in empirical studies to relax or validate assumptions about expectations. [6] The conclusion of his 2004 survey reads " I have concluded that econometric analysis of decision making with partial information cannot prosper on choice data alone….. Economists should abandon their antipathy to measurement of expectations. The unattractive alternative to measurement is to make unsubstantiated assumptions. "

An illustrative example

A recent study of job changing behavior provides a good example of how forecast errors impact on identification. The exploration was performed on a large longitudinal sample of Italian male workers between the mid 80's and the mid 90's, a decade characterized by an expansionary period through the early 90's, followed by a long recession.[7]. Movers and stayers were observed

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[4] The idea that real life choices are essentially among discrete options was present also in Arrow's impossibility theorem: the argument was made by Majumdar (1969) in response to Contini (1966). Contini's result - the postulate of "relevance of irrelevant alternatives" being tautologically true, and therefore irrelevant when the choice set is continuous and compact - was assessed as scarcely interesting for the very reason that any realistic choice set of a social planner is discrete.

[5] None of the above decisions involve repetitive situations where external conditions are constant, learning about future events allowed to take place and rational expectations formed. A job switch (aside, perhaps, for a very young person at the beginning of his working life) is usually a long term investment. Purchasing a new house is an almost irreversible choice involving big exit costs, especially if you realize that your neighbors are unbearably unfriendly. Deciding to bear a third child at age 45, ten years after your last one, may change the course of one's life.

[6] Perceptions of job insecurity in response to verbal questions such as the General Social Survey are available through the Survey of Economic Expectations (SEE), as discussed in Dominitz and Manski (1997). Manski (2004) reviews a number of case studies where data on expectations have been collected. He mentions that outside the U.S. only in the Italian Survey of Investment in Manufacturing are firms asked to provide probabilistic predictions of product demand (Guiso and Parigi, 1999).

[7] B. Contini, "Testing bounded rationality vs. full rationality in job changing behaviour", W.P. LABORatorio R. Revelli (2008), and IZA W.P In this paper I argue that bounded rationality appears to explain job changing outcomes better than models assuming full rationality. Forecasting errors on the

after three years since the decision to move or stay, on the assumption that such options are evaluated over a relatively long time horizon. Workers will consider mobility as a profitable alternative to their current position on the basis of two main elements: future expected earnings (long run wage growth) and expected job quality or job safety. The role of expectations on future events is, therefore, of crucial importance for move-vs-stay decision. Some workers may be risk-averse, some overconfident and take more risks than others facing a given job offer; some may decide on the basis of their colleagues' advice and act out of salience (she/he has done well, the same will happen to me).

Fig. 3 : Wage growth percentiles (movers & stayers)

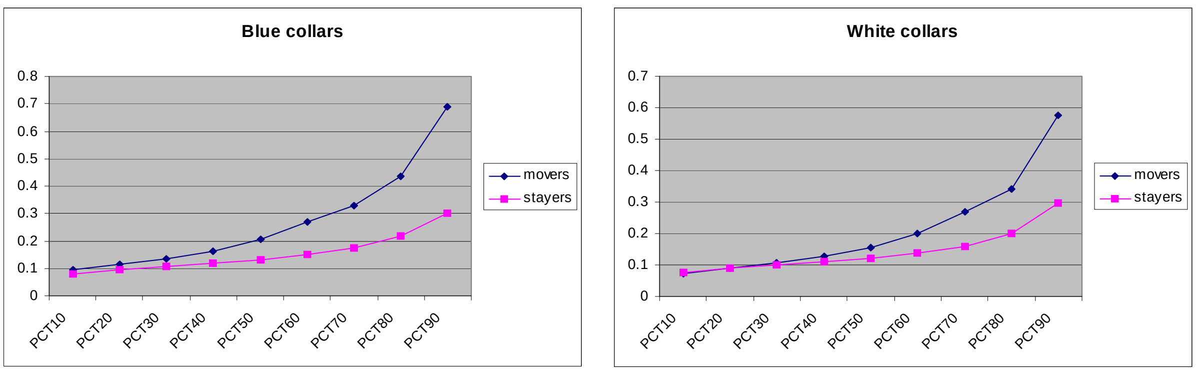
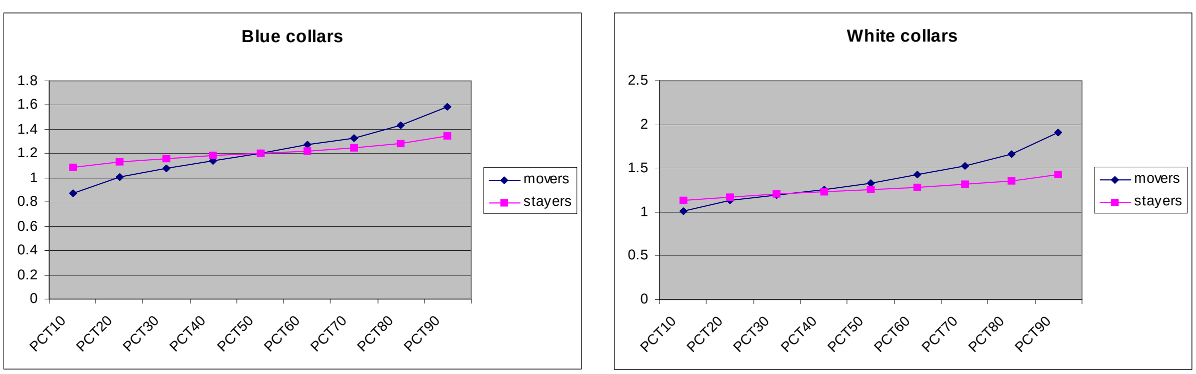


Fig. 4 : Risk-on-the-job percentiles (movers & stayers)



timing of recession is certainly one of the causes of many bad outcomes observed in this exploration, but not the only ones. One of the main hypotheses of bounded rationality rests on the fact that people have limited information and are unable to process it correctly. Thus forecasting errors are one of many different aspects that characterize bounded rationality.

Fig. 3 and 4 display the unconditional percentile distributions of wage growth and risk-on-the-job of movers and stayers: while more than 50% of the movers do better than their fellow stayers in terms of wage growth, 80% do much worse in terms of risk-on-the-job.[8]

Fig. 5 displays the scatter of movers' outcomes: wage growth and risk-on-the-job, conditional on a large set of covariates (age, industry, firm size, skill level, geographical location, individuals' past history). Any reasonable utility function defined in terms of wage growth and risk-on-the job should yield a positively inclined efficiency frontier, improving in the N-E direction.[9] This scatter reveals almost nothing, except the fact that, wherever a positively sloped efficiency frontier may lie, the vast majority of observations is strongly dominated by those (very few) relatively close to any of such frontiers.[10]

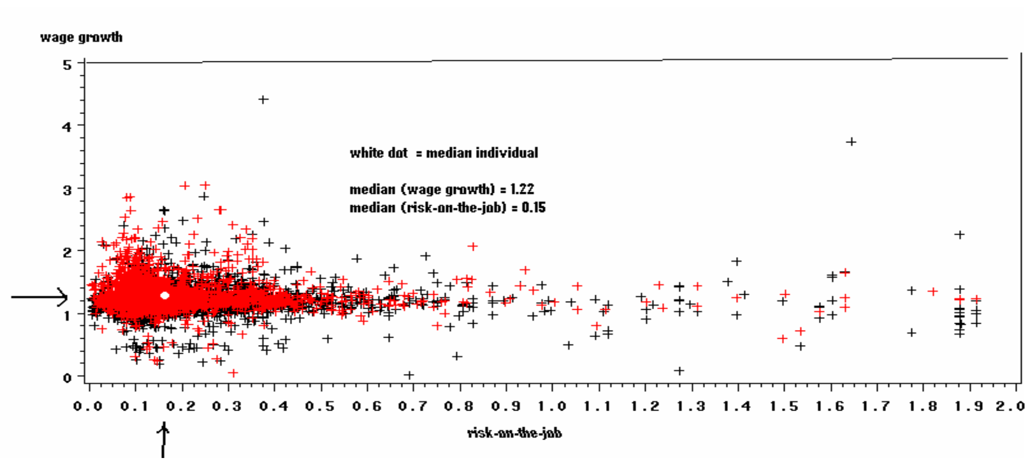


Fig. 5 – The outcome space of 1150 movers

A fragile, although significantly positive trade-off between wage growth and risk-on-the-job has been estimated at 0.08.[11] The huge downward bias of this estimate is evident with a simple calculation: the median mover aiming at a modest increase of 2 p.p. in wage growth in three-years-time (from 1.22 to 1.24. The 75-percentile of wage growth is 1.55, which is 33 p.p. higher than the median), appears to be willing to trade it for an enormous increase of risk-on-the-

[8] Risk-on-the-job is measured as the ratio between the worker-specific predicted likelihood of dismissal in the past 1986-91 time window and a forward looking firm-specific indicator of employment trend over the subsequent three-year period 1991-94. Real wage growth is here measured by w(t) / w(t-3) on a three-year window starting at the time of the job switch (it is therefore equal to (1 + growth rate)).

[9] A simple Cobb-Douglas utility yielding a linear efficiency frontier is
U = wage growth/risk-on-the-job. A more general utility function
U'= (wage growth)**m / (risk-on-the-job)**n, with m, n positive integers, will simply change the slope of the frontier.

[10] In the original paper (Contini, 2008) the distance of the large majority of observations from any plausible efficiency frontier is interpreted as one piece of evidence in favour of bounded rationality.

[11] B. Contini (2008), p. 16.

job, from his median value of 0.15 up to 0.33 which is way above the 75-percentile (equal to 0.25). A tradeoff of this magnitude makes no sense. Why do we get such a result that persists after a variety of robustness tests ? The difficulty of forecasting into the future must have played a major role. The recession began to creep in the Italian economy in early 1992 after a 5-year expansion period, reaching its trough in 1994. Employment took a sudden downturn in many industries, well below what could have been reasonably expected at the beginning of the Nineties: a striking 25% of the sample movers who switched jobs around 1991 end up in firms that exit the market before the end of 1994, while only a more modest 10% of the stayers (who did not make the switch) are in the same position. A large number of job changers must have held over-optimistic predictions of risk-on-the-job, responsible for very negative consequences on outcomes.

Problems caused by incompetence, ignorance of the environment, difficulty of predicting future events appear in a variety of different contexts, and especially in studies of investment and/or financial decisions. For instance,

S. Benartzi and R. Thaler (2007) report financial and investment decisions that look almost casual, often dictated by prejudice and ignorance. T. Jappelli (2007) and A. Lusardi (2007) report analogous results in the choice of retirement plans. In all these cases any attempt to estimate risk propensity (or any other parameter of the utility functions) from the individuals' ex-post decisions is bound to yield severely biased results. Estimated behavior will appear unreasonable, as was found in the previous example of job-switching. It would be insane running to the conclusion of attributing to the Benartzi-Thaler-Jappelli-Lusardi investors features of risk propensity estimated from their own behavior.

Conclusion

Imperfect information (and, consequently, wrong courses of action) lead to inefficient resource allocation, unless there are appropriate insurance markets. Not surprisingly, imperfect information and the possibility of making wrong predictions on future events is the cause of serious drawbacks also on identification.

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