Three Essays on Economics of Non-Market Institutions

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To My Family

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Abstract

This thesis is a collection of three essays on the economic consequences of a number of primarily non-market institutions, more precisely visual artists' compensation scheme, religiosity and social influence. Methodology varies across the different chapters of this thesis: I use experimental, empirical and theoretical tools. In its contents this thesis contributes to the growing efforts made by scholars and researchers to build a bridge among social science disciplines, mainly psychology, sociology and law with economics.

In my first essay I model a work of art as a lottery in order to compare the two dominant compensation schemes for visual artists (painters and sculptures): with or without resale royalty. After the analysis of the experimental data I find that, in accordance with my conjecture, a number of behavioural biases in decision under uncertainty are present in resale royalty regime. I conclude that resale royalty influences not only production and selling decisions of artists but also their welfare.

In the second paper using the Ethnic Diversity Survey, I examine how religious belief and practice relate to earnings in Canada. I consider the impact of the degree of religiosity using a composite score-based variable constructed by means of several questions in the survey. I also examine cross-religion differential in earnings and human capital return. I find that Jews enjoy a premium and Muslims' earnings are significantly lower compared to the average. I find that the lower return to experience of Muslims explains a large portion of their earnings gap and it is caused by the immigrant status of their great majority.

My third essay proposes a modified version for the replicator equation. The replicator equation, originally conceived in evolutionary biology, is routinely used for

modelling the evolution of preferences and social norms, conceived through population proportions of types. My proposed version incorporates the components of social influence into the equation not only making the justification for its use in economics more solid but also it helps providing an explanation for some observed socioeconomic patterns that could not be otherwise explained.

Résumé

Cette thèse est une collection de trois essais portant sur les conséquences économiques de certains comportements hors marché, plus précisément la compensation des artistes en arts plastiques, l'effet de la a religiosité sur le salaire au Canada, ainsi que l'influence sociale. J'utilise diverses méthodologies dans cette thèse : expérimentation économique; analyse empirique ainsi que des outils théoriques. Le leitmotiv de cette thèse est, donc, de construire un pont entre les sciences économiques et les autres disciplines telles la psychologie, sociologie et droit.

Dans mon premier essai je modélise les œuvres d'art plastique comme étant des loteries pour comparer les deux régimes dominants de la compensation des artistes, avec et sans *droit de suite*, à l'aide d'une expérience. En analysant les données générées par l'expérience, je trouve que des biais comportementaux dans la décision sous l'incertitude sont exacerbés par le *droit de suite*. Je conclue que *le droit de suite* peut influencer les décisions des artistes sur la production et la vente des œuvres d'art mais aussi leur bien-être.

Dans mon deuxième essai j'emploi les données de l'enquête sur la diversité ethnique canadienne dans une étude sur la relation entre les religions, la religiosité et le marché de travail. Je construis un index de religiosité en utilisant trois questions de l'enquête. Je compare également les différents groupes religieux au Canada en matière de salaire horaire et retours au capital humain; trouvant ainsi que le salaire horaire supérieure à la moyenne des juifs s'explique par un retour sur expérience plus élevé. Je trouve un décalage de salaire horaire dans le sens opposé pour les musulmans qui semble être causé par le statut d'immigrant de leur plus grande majorité.

Mon troisième article propose une version modifiée de l’équation de replicateur qui est régulièrement utilisée dans les études d’évolution des préférences et des normes sociales. Cette version proposée intègre dans l’équation des forces qui sont suggérées d’être derrière l’influence sociale. J’examine ensuite cette version de l’équation pour en tirer des conséquences qualitatives. Je démontre que ma proposition peut fournir une explication pour certaines observations socioéconomiques, inexplicables auparavant.

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Introduction

This thesis is a collection of three essays on the economic consequences of a number of primarily non-market institutions. In its contents this thesis contributes to the interdisciplinary researches aimed at using economic insights and methodology in understanding other social institutions studied more frequently in other social science disciplines.

My first essay examines the economic consequences of visual artists' compensation schemes as stipulated in different legal systems (coauthored with Professor Jim Engle-Warnick). There are many situations in which a seller retains a portion of the property he or she sells. One such institution is called "droit de suite", or "resale royalty", in which a visual artist receives a royalty payment every time his or her work of art is resold. We model a work of art as a lottery, and experimentally study the effect on willingness to accept when a seller retains a small portion of the lottery. We find that lotteries with small probabilities of high outcomes are overvalued by the seller compared with other lotteries. We conclude that resale royalty may influence production and selling decisions of artists.

Using the Ethnic Diversity Survey (EDS), I examine how religious belief and practice relate to earnings in Canada. I consider the impact of the degree of religiosity using a composite score-based variable constructed by means of several questions in the survey. I use this index as an explanatory variable in the estimation of standard human capital-earnings function. A negative correlation between religiosity and earnings is found controlling for demographic, behavioural and human capital variables. Examining the cross-religion differential in earnings and human capital return, I find that Jews enjoy

a premium and Muslims' earnings are significantly lower compared to the average. I find that the lower return to experience of Muslims explains a large portion of their earnings gap and it is caused by the immigrant status of their great majority.

The replicator equation is one of the standard frameworks for evolutionary analysis. It is used for modelling the changes in population proportion of types through selection mechanisms. This work proposes a modified version for the replicator equation that incorporates incentives behind social influence suggested to be conformity and status-seeking. In my proposed version they are formulated in terms of population proportions, leaving the analytical tractability of the replicator equation intact. The equation is then examined in order to derive its main patterns. It is shown through illustrative examples that this version of the equation proves to be both empirically useful and theoretically instructive.

Contribution of Authors

The research article "Visual Artists' Resale Royalty and Risk Preference: An Experimental Approach" included in the Chapter 1 of the present thesis is coauthored with my supervisor Professor Jim Engle-Warnick. I have contributed the research question, the design of the experiment and the data analysis as well as the main part of the interpretation and commentary of the results.

Professor Engle-Warnick has helped with the refinement of the experimental design and the interpretation of the results. He has also funded the experiment accommodating it in CIRANO's experimental laboratory.

Chapter 1

Visual Artists' Resale Royalty and Risk Preference: An Experimental Approach

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I. Introduction

Attitude towards risk is important when it comes to decisions regarding artistic endeavour: whether deciding what to create, when to create it, how to create it, or for whom to create it, a work of art carries an uncertain return. In some cases this uncertainty involves low probabilities of large payoff. In other cases it can be argued that the uncertainty involves unknown probabilities of payoffs, or ambiguity.

In practice, the expected financial return of works of art and literature, upon their inception and before the resolution of uncertainty about the actual value of the work, turns into a transferable title, a copyright, with a market determined value. Therefore the artist is able to exchange the uncertain financial return for a guaranteed lump sum amount of money and the risks are transferred to the eventual buyer of the title, perhaps a professional investor who is in the position of pooling the risks. While the artist must still evaluate risks to decide on keeping or selling the title (copyright), copyright institution gives "an option" to the artist to replace his or her risky compensation with a sure amount of money.

The situation created by the institution of copyright seems desirable since it provides the artist with an opportunity to decide on the amount of risk she or he is willing to bear at each point in time. Still, the flexibility in managing the risks inherent to the artistic undertaking offered by copyright does not equally benefit all copyrighted works. The reason is a material impossibility: not all works of art can be reproduced. Although painting and sculpture are subject to copyright prerogatives, since it is impossible to disassociate them from their original material form, the copyright attribute that entitles the author to receive the financial yields of the reproduction of the work is naturally inoperative. Hence, the principal way for a visual artist to monetize her or his works amounts to selling its material form[1].

Since copyright includes, in general, the right of the author to financially profit from reproduction, display, and adaptation of the work, one can easily see how, for example, a written symphony, a movie, and a painting will necessarily result in different components of copyright for their respective authors. This point, the natural impossibility of reproduction in painting and sculpture, has been gradually considered by most legislators and as a result the copyright on painting and sculpture often incorporates a special attribute that is usually called *droit de suite* for the sake of its French origin (meaning *right to follow* and translated to *visual artists' resale royalty* or *resale royalty* for short in English speaking countries; in this paper these terms are used interchangeably). The visual artists' resale royalty right, or *droit de suite*, entitles the author of an original work in the domain of visual arts (i.e., painting and sculpture) to an economic interest in its successive sales, usually in form of a percentage of the price received by the owner of the work, subject to certain legal requirements.

After the French recognition of this right in the first half of the 20th century, other countries in continental Europe have gradually adopted a version of it (an except is Switzerland). Legally speaking, *droit de suite* became a part of copyright dispositions in Civil Law (as opposed to Common Law) regimes. In European Common Law countries, the adoption was long debated but has only taken place recently as a result of an EU harmonization directive in 2001. The EU directive led to the recognition of this right in

[1] Although producing posters, lithographs and the like from visual art works are regulated by copyright laws around the world they are not reproduction in its legal sense as they involve the change in the medium of expression. And note that first, they became possible only in the later parts of 20th century; second, their monetary yield for the artists tend to be modest. We use "reproduction" in this paper in its strict legal sense.

the UK and the Republic of Ireland. As of Common Law countries outside EU, Australian artists have long argued that the lack of recognition of *droit de suite* disadvantages them in comparison with their counterparts in other countries. Finally, Australia and New Zealand integrated *droit de suite* into their national legislations in 2009. In Canada, *droit de suite* is not invested and in the United States this right is only recognized in the state of California. Given the considerable share of the United States in the market of visual arts, the US recognition of this right at the federal level is a consequential economic issue. Harmonization of the law across the world could stimulate trade by providing comparable financial returns regardless of the jurisdiction in which the sale takes place and also by taking away the complexity of the possible legal matters emanating from the involvement of multiple jurisdictions (conflict of laws) with different regulations[2].

Most economists who have analyzed this right have concluded that it is relatively inefficient due to its intervention in the free negotiations of sellers (artists) and buyers (dealers/collectors). This conclusion has contributed to the lack of recognition of this right in the US, leading to the current discrepancy in the contents of copyright laws among developed countries. This situation may induce the artists (dealers) to prefer selling or auctioning the works in the jurisdictions where such right is (not) recognised such as Paris or London (New York) creating a form of art auction haven. Moreover, it can cause important and costly legal complications in the cross-border movement of such works of art.

[2] Conflict of laws is a set of procedural rules which determine which legal system, and the law of which jurisdiction, applies to a given dispute. The rules typically apply when a legal dispute has a *foreign element* from the stand point of the judicial system in which the dispute is being resolved (such as a contract agreed by parties located in different countries). The jurisdiction in which the dispute is being resolved impacts the national law that will be ultimately applied. If the contents of national legislations are different then this jurisdiction becomes important for the outcome of the dispute.

Visual artists' resale royalty right creates a *sui-generis* scheme of decision under uncertainty by affecting not only the total payoff of such artistic endeavours but also the distribution of payoffs over time. Given the behavioural biases previously uncovered in such settings, it is plausible to think that the institution is susceptible to affect artists' decisions about the sale of their works (as opposed to retaining it for themselves) but also their production decisions and, as we will argue in this paper, their welfare.

This paper contributes to the literature examining the efficiency of this institution from the angle of artists' incentive to sell their work under this right, using an experimental approach. The results are also used to shed light on the artists' production decision and their welfare. We conjecture that the institution may adversely affect the number of transactions in the art market due to a version of endowment effect. We also conjecture that, assuming the degree of risk aversion is affected by the magnitude of the stakes, the resale royalty institution may similarly lead to fewer transactions in the market while adversely affecting artists' welfare as well; both of the effects resulting from lowered risk aversion in face of this institution. Analysing our results, which turn to be in accordance with these conjectures, we conclude that fixing a relatively high threshold for this right to take effect can largely eliminate the adverse impact of the institution on the number of transactions while providing incentive for more promising artists. We also examine the ability of a non-expected utility model to fit the experimental data, further providing evidences that the resale royalty regime induces behaviours not adequately foreseeable by the rational choice framework, as will be detailed in the subsequent sections.

The reminder of the paper is organised as follows. In the next section we elaborate on the institution's origin and its implications on the visual artists' behaviour. The next section elaborates on the design of the experiment. The analysis of experimental data and the results of our estimations follow. The last section concludes.

II. Behavioural Impact of Resale Royalty

Looking at the history of visual arts, it can be argued that the uncertainty of payoffs and its ensuing impact on the artists' stream of income has contributed to the prevalence of the *patronage* system from ancient times until modern era. During this long period, the members of aristocracy provided the artists of their choice with financial support in its absence the creation of works of art would be greatly undermined. In some sense the patron acted as the principal and the artist as the agent. The transition of social institutions into their modern visage eliminated the patronage system and let laws and other social institutions take the place of private patrons. From this instance, it should be expected that these institutions provide a set of comparable incentives for the creation of visual arts. It is shown that *droit de suite* is, in fact, an efficient tool when the policy-maker intends to promote the production of visual arts, due to its compatibility with the optimal contract for the context (see Dilmaghani, 2008). However, *droit de suite* has been originally conceived to improve financial situation of the artists rather than the promotion of visual arts.

The anecdote behind the original creation of *droit de suite* goes as follows. The French painter Jean-François Millet's 1858 famous painting, *L'Angélus*, was resold after the First World War in an auction at a considerable price, while the artist's family was living in poverty. It is said that the painter's daughter had been selling flowers in the streets of Paris at exact same day of the auction[3]. The account of this event reached the French Parliament and as a result the resale royalty right was conceived.

Hence, historically, two considerations have motivated the French legislator to grant this right: the material welfare of the artist and fairness. Given that, unlike other artistic and literary works, visual art works cannot be reproduced in the strict sense, the monetary compensation of artistic endeavour for a non negligible proportion of these artists can be quite modest. Furthermore it is usual that the price of a piece of art substantially increases over time, usually as a result of the establishment of the artist's name and reputation. In economic terms, there is a positive externality instigated by the artist's later success in her or his career to the benefit of the subsequent owners of any of this artist's works and *droit de suite* acts to internalize this externality. This implication of the right is usually interpreted as the legislator's fairness concerns. We notice in the more recent commentaries that the concern of legislators and the *rationale* behind the right have been widely interpreted as protecting the weaker party of the transaction (the artist) against the abuse of the party with higher bargaining power (the art dealer). This interpretation implies that *a priori* there is a discrepancy between the desirable solution in eyes of a hypothetic central planner and the market solution.

This right is typically specified by law as a percentage share of the sale price which decreases as the sale value of the work of art increases. It covers a period similar to the validity period of other copyrights. Moreover, the right is inalienable, which means that the artist cannot contractually or otherwise withdraw from it at the moment of the

[3] Jean-François Millet (1814-1875) spent his youth working on the land, but by 1837 he arrived in Paris and eventually enrolled in the studio of Paul Delaroche. The peasant subjects from the early 1850s were Millet's principal concern as a result, periodically faced the charge of being a socialist. Important collections of Millet's pictures are to be found in the Museum of Fine Arts in Boston, and in the Louvre.

first sale or later on. In some sense this right makes an exception over normal attributes of property rights since it creates a legislatorial quasi-shared ownership over the stochastically valued property of the work of art. In some other sense it forces the artists to subscribe for a statutory insurance plan, for in the state of their success they receive extra compensation in exchange of, as we will elaborate on below, a somewhat lower first sale price.

Not all paintings and sculptures are eligible for resale royalty. In general, all legislations have limited the right to the cases where the work is resold in an auction or *via* a professional art dealer and its resale price is higher than a legally specified threshold. Table 1 displays the ranges of resale prices and their corresponding regulatory percentage share of the artist along with the average amount of royalty received by the artist within each range, as it can be currently found in French law.

What is the effect of *droit de suite* on the market for visual arts? In other words, how the equilibrium values of the market (the number of transactions and the price) will be affected by resale royalty? Many economists who have analyzed this right have concluded that it is rather inefficient for various reasons. For instance, Greffe (2005) found evidences that it reduces the number of transactions in the market as well as the first sale's price, resulting in an adverse economic effect on the artists especially the young ones (Coase 1972, is a more general treatment of this issue). Solow (1998), in a model of optimal risk sharing, reaches the conclusion that *droit de suite* results in inefficient risk taking of a risk-averse artist contracting with a risk-neutral dealer. Stanford (2003) argues against the administrative costs of implementation of *droit de suite*. Other researchers emphasize market structure in the analysis of the impact of *droit de suite*: Perloff (2003), for example, discusses the uneven bargaining power between artists and art dealers, concluding that the dealers earn excess profits at the expense of the young artists hence *droit de suite* is a desirable remedy (see also Filer 1986).

Overall, the interventionist nature of this right has motivated more criticism than support among economists. The conclusion that *droit de suite* is inefficient, expressed by the majority of economists, has contributed to the non-harmonization of the right across legislations. From the view point of general economic principles, both willingness to pay (alternatively termed WTP) and willingness to accept (alternatively termed WTA) for a painting (or sculptor) in its first sale should decrease in a regime that enforces *droit de suite*. The reasoning is straightforward: the selling artist may receive extra compensations through resales in the future, while the buyer (dealer or private owner other than the artist herself) will have to pay a percentage of the price received in a future transaction to the artist. These two effects act on the willingness to accept (willingness to pay) of the artists (dealers) towards an overall higher (lower) price received than the first sale price. Thus, the market equilibrium first sale price is expected to decline, but not necessarily the number of transactions. The extension of this simple analysis to the number of transactions (and its postulated fall) requires further assumptions such as risk aversion of the artists and risk neutrality of the dealers.

However, since the revenues from resale royalty are uncertain (they are conditioned on the incidence of resale at a price higher than the legal threshold within the validity term of the resale royalty) and occur over time, when one takes into account the behaviour biases in risk and time discounting then predicting the impact of the institution may not be as straightforward as it seems. This study is conceived to further investigate the impact of *droit de suite* on market equilibrium values taking into account some of the well-known behavioural biases in decision making in such contexts.

First conjecture is the impact of *endowment effect*. Endowment effect postulates that agents tend to demand more money for an object they already own than when they do not own it. Endowment effect is mainly documented, in experimental studies and survey elicitation methods, through the larger sum expressed as the willingness to accept than the willingness to pay for the same object (see for instance Hammack and Brown 1974; Rowe *et al.* 1980; Knetch and Sinden 1984; Brookshire and Coursey 1987; Knetch 1989).

There have been a vast number of theoretical and empirical studies detailing and explaining this effect and attempts have been made at explaining it. One explanation involves the fact that economic theory itself predicts this phenomenon for goods with no close substitutes (Hanemann 1991 and Shogren *et al.* 1994). It is reasonable to assume that a significant proportion of visual art works fall into this class of non-substitutable good, making it a plausible candidate for a study involving elicitation of willingness to accept (willingness to pay) on the part of the artists (dealers).

Note that endowment effect must be present with or without resale royalty but we conjecture that the bias can be exacerbated by the institution: *droit de suite* practically and psychologically extends the ownership relationship of the artist to the work in time by setting the artists to receive a percentage from each resale price. This feature of the right, we believe, can intensify the bias caused by endowment effect pushing the willingness to accept in the first sale upward.

Second, using general neoclassical theory principles, both risk and time preferences would operate on decisions in a market place involving *droit de suite* and these two concepts are associated with behavioural biases as well. Simply put, risk aversion would lead to a lower acceptance price on the part of the artist (swapping a sure payment for a gamble), as would discounting over time. But while economic theory makes a straightforward prediction, actual behaviour may be different. Kahneman and Tversky (1979) provided the first evidences and modelled with their prospect theory, the fact that people appear to overweigh small probabilities of good outcomes in gambles. The extent to which an artist may believe that there is a small probability of a large payoff for his or her art may have an important effect on the price he or she expects to receive.

Again, this bias must be present with or without resale royalty but the interaction of this bias and resale royalty can work to actually, all else equal, diminish the willingness to accept for the work in the first sale. The reasoning is straightforward: if the small probability of a subsequent resale is overweighed by the artist then the expected future payoffs through resale royalty are overvalued and this brings the artist's willingness to accept in the first sale down.

Third, there are evidences that the lager the stake the greater the degree of risk aversion (Holt and Laury 2002; Engle-Warnick, Escobal, and Laszlo 2009). The existence of resale royalty makes the risky stakes smaller therefore it is susceptible of impacting risk aversion downward causing the artists to ask for a higher price in the first sale.

The issue of time-discounting and its associated behavioural biases come into play given that resale royalty is granted for a significant period of time. It means that the expected stream of revenues from resale royalty, considered at the moment of the first sale, should be discounted by the artist. A standard behavioural finding associated with intertemporal decision making is the *present bias* where subjects discount the present payoffs *vs.* the immediate future payoffs more heavily than they do between any other two adjacent periods both situated in the future. Hyperbolic discounting is another interpretation of the observed biases in actual behaviour compared to discounted utility framework (e.g. Rubinstein 2003; Behabib and Bisin 2004; Anderson *et. al*. 2008, Engle-

Warnick, Heroux and Montmarquette 2009, and the references therein; see also Frederick, Loewenstein and O'Donoghue 2002, for a survey of previous studies).

Setting aside the issue of time preferences for the current research and supposing that the work of art produced by a visual artist (i.e., either a painting or a sculptor) is analogous to a lottery. Based on the experimental evidences and behavioural findings that have been mentioned in the above we can put forward three behavioural conjectures about the impact of resale royalty on the artists' willingness to accept. They are listed below.

First, as a long line of evidence exists that the endowment effect biases willingness to accept for *gambles* owned by the decision maker in a similar manner to the objects we think:

(1) All else equal, artists' (experiment subjects') valuations elicited through their willingness to accept for a lottery (standing for a work of art) will be *higher* in the presence of *droit de suite*. This conjecture is based on the extended sense of "ownership" created by the resale royalty institution for the creating artist.

Second, prospect theory states that subjects overweight small probabilities of good outcomes:

(2) All else equal, artists' (experiment subjects') willingness to accept will be higher for the lotteries with low probabilities of high outcomes. This pattern in combination with the fact that resale royalty only covers works priced higher than a legally specified threshold means that, all else equal, the artists may state a relatively lower willingness to accept in the presence of resale royalty institution. The reason is that overestimating the low probability of a future high price for the work results in a higher expected future payoff hence *lowering* the willingness to accept in the first sale.

Third, according to Holt and Laury (2002), the degree of risk aversion is affected by the magnitude of the stakes hence:

(3) As resale royalty makes the stakes of risk taking smaller then the artist should become less risk-averse in the presence of resale royalty. Lowered risk aversion affects willingness to accept upward as expected utility gets closer to expected value.

Putting (1), (2) and (3) together (two effects towards a higher willingness to accept and one towards a lower one), we conjecture that willingness to accept will decline less than proportionally with the resale royalty i.e., less than how willingness to accept would have fallen in the absence of these behavioural biases (inclusive of risk aversion as postulated by neoclassical theory). This implication of *droit de suite* may lead to the fall of the number of transactions especially if the professional art dealers are more prone to decide based on rational choice principles without being subject to behavioural biases: with this institution the artist's willingness to accept falls less than the dealer's willingness to pay resulting in the incident of failure to transact. We expect to find this pattern -less than proportionate fall of willingness to accept- in settings meant to replicate resale royalty institution in our experiment. The details of the design follow.

III. Design of the Experiment

We are interested in the impact of *droit de suite* on the reservation price of an artist for her or his painting or a sculpture. Thus, our experimental design embeds a standard measure for risk preferences: incentive-compatible elicitation of WTA. We model the art produced by an artist as a lottery, with risky payoffs[4]. We model skill-

[4] As it is our first examination of this subject, we abstracted from the issue of time preferences, interpreting our lotteries as total present values of an income stream.

dependant types of work by a safe gamble, while original works whose value may tremendously differ according to the state of the world are captured by risky gambles[5].

Under resale royalty, the artist retains a fraction of the value realized from all future sales of her or his art, and in our experiment the subject retains a fraction of the lottery payoffs. In the absence of resale royalty, the artist accepts payment and forfeits property rights over any future sale, and in our experiment the subject retains no part of the lottery payoffs. This design allows us to test our behavioural conjecture that resale royalty institution is susceptible to diminishing risk aversion.

The subjects have been endowed with 30 lotteries and were asked to express their WTA for them. The lotteries can be divided into two categories: (1) safe gambles whose payoffs were either \$15 or \$25; (2) risky whose payoffs were either \$1 or \$40. We constructed 5 risky and 5 safe gambles by varying the probability of the low outcome as follows: 0.1, 0.3, 0.5, 0.7, and 0.9. Thus, there are ten basic gambles in the design, five safe (\$15 or \$25) and five risky (\$1 or \$40). Resale royalty is accounted for by 20 extra questions in which subjects are asked to express their WTA for only 95% of the lotteries' payoff and only 80% of the lotteries' payoff while retaining the remaining portion of the gambles. Our design therefore led to six different configurations.

Therefore, we were able to compare subjects' responses under the standard elicitation of risk preferences (0% royalty) with their responses when they retain a portion of the lottery (5% and 20% royalty) as we observed ten decisions for each category per subject. Our experimental design embeds another test of revealed preference over

[5] One may argue that the uncertainty seen by the artist is endogenous in the sense that, for example, the artist may be making an effort to build a reputation. The advantage of the experimental laboratory is that one may abstract from such issues and focus, as we do here, directly and solely on the effect of retaining a fraction of the property being sold. Issues such as time and endogeneity remain open questions for future studies.

lotteries: the impact of resale royalty on decision making when the lottery has a high variance compared with when it has a low variance (i.e., risky versus safe gambles).

The decision tasks were provided to the subjects in six decision sheets, each containing the five different gambles associated with the five variations in the probability of the outcomes of the gambles. The gambles were presented as pie-charts, and probabilities of outcomes were communicated as "chances out of 100". The pie-charts were arranged in descending order with respect to the probability of the good outcome. The six decision sheets were randomly ordered for each subject (see Hey and Orme 1994 and Wilcox 1997 for comparable concerns). An example of the decision sheet is given along with the experimental instructions in Annex 2. Table 2 summarises the decision tasks.

Insert Table 2.

The upper panel of Table 2 presents the questions featured in the experimental design as well as the gambles' expected value. The table is divided into two halves, left and right, presenting the payoffs for a relatively risky gamble (either $1 or $40), and for a relatively safe gamble (either $15 or $25). The rows of the table show the five risky and five safe gambles. Each half of the upper panel of Table 2 is sub-divided into three columns representing the three resale royalty regimes. The column labelled 0% represents the absence of resale royalty. The columns labelled 5% and 20% represent situations where, upon the sale of the lottery, the subject still retains either 5% or 20% of the lotteries' payoffs respectively. It was made clear to the subjects that in the latter cases the remainder of the lotteries would be played and they would receive the outcome in addition to their payoff from the portion (95% or 80%) whose ownership was set to be transferred.

The cells of the table present the valuation for each lottery by a risk-neutral expected utility maximizer. For example, for the gamble with a 0.1 probability of $1 and a 0.9 probability of $40, this valuation (expected value) is $36.10. For the gamble with a 0.5 probability of $15 and 0.5 probability of $25, this valuation (expected value) is $20. For these same gambles with a 20% royalty, the valuations reduce to $28.88 and $16.00 respectively.

We used the Becker-Degroot-Marschak (1964) procedure to elicit valuations in an incentive compatible manner. Briefly, the subject states their willingness to accept, and then a number is drawn from the uniform distribution with a support from $0 to $50. If the number drawn is larger than or equal to the stated WTA, then the subject receives payment in the amount of the number drawn and surrenders the lottery. Otherwise, the subject keeps the lottery.

This procedure, which amounts to a second-price auction with the experimenter as a random bidder, may prove complicated for untrained subjects to fully understand, and for this reason it may result in noisy subject responses. To counteract this, we explained the procedure to the subjects, and gave standard examples as to why it was not in their best interest to misreport their valuation. Subjects took a quiz after the experimenter read out loud the instructions and answered any questions. The experiment continued after all subjects' answers had been corrected by the experimenters. The instructions are replicated in Annex 2.

Sixty-four subjects participated in the experiment, thirty of whom were men, and all of which were drawn from the standard subject pool consisting primarily of undergraduates and recent graduates of universities located in the province of Québec, Canada. Thirty-one subjects reported themselves as students, while the rest were self-employed, employed in the private or public sector, or unemployed. The average age of the participants was twenty-six.

Subjects were paid for one decision, randomly chosen from all thirty decisions they made in the experiment, plus a $10 show-up fee which is standard at our experimental laboratory. The subjects were paid privately, and the randomization was done using the random number generator function in Excel. Overall, thirty-three subjects actually exchanged their lottery for cash, and the average payment was $45, including the $10 show-up fee.

Finally, a note on the external validity of our experiment is in order. It can be argued that the population of artists may have a different risk preference distribution compared to the subjects in our experiment (see King 1974, Caves 2003). We have considered this question prior to the design of our study. There are two distinct arguments for the external validity of our experiment. First, the question we address is about the decisions made by young, debuting artists that share many characteristic with the subjects of your experiment, mainly young students. Second, our intention is to compare the impact of two different institutional setting on risk preferences, taking as given the individual fixed effects. In other words, the intention is to learn about the relative impact of the institution. Therefore, we expect that, although the two populations' risk-preferences may differ, the relative impact of the institution must be qualitatively comparable across the populations.

IV. Results

In this section the results of the experiment are presented. In the first subsection we report the descriptive statistics obtained from our experimental data. In the next subsection we assume various latent decision making models and we estimate the parameters of these models.

3.1. Descriptive Statistics

The lower panel of Table 2 presents mean willingness to pay for all decision tasks in the experiment. The table includes data from our 64 subjects[6]. First, comparing the lower panel of Table 2 with the risk-neutral predictions in the upper panel, subjects appear to be risk-loving. This is in contrast with some other reported results, as in Holt and Laury (2002), where the subjects' behaviour is found to be typically risk-averse (however, note that Holt and Laury experiment differs from ours in eliciting risk preferences through binary choices rather than willingness to accept). This is consistent with our first prediction of the effect of WTA on revealed risk preferences. Also, consistent with our second behavioural prediction, subjects appear to be overvaluing the lotteries with a 0.9 probability of the low outcome, compared with gambles of higher probability of the better outcome.

Most importantly, it is visible that the subjects' valuations are not declining proportionally with the increase in the percentage royalty that they are supposed to receive subsequently. Roughly speaking, for example, for the risky gamble of 0.1 probability of best outcome, $37.45, the mean reported willingness to accept for 5%

[6] We dropped two subjects from the sample as their answers revealed they did not understand the experimental protocol. Because the maximum amount that the computer could draw under the BDM procedure was $50, reported WTA's above this amount convey no information consistent with incentive compatibility of the experiment. Therefore the WTAs are truncated at $50. This truncation did affect quantitatively or qualitatively the estimation results.

royalty is not a 5% discount on $36.99, which was the mean willingness to accept reported for no royalty, and $35.89 is certainly not a 20% discount on $36.99. Strikingly, Table 3, which conducts statistical tests for the difference across royalty levels report no difference in WTA even at the 10% level. Thus, there is no discernable pattern of proportionate decreases across the table as the royalty percentage increases, which is consistent with our behavioural prediction.

Insert Table 3.

We wanted a better look at the distribution of WTA given the failure of t-tests in Table 3 to detect a statistically significant difference between WTA across royalty levels termed Premium). Figure 1 and Figure 2 present non-parametric plots of the distribution of the difference between WTA and expected value of the gambles aggregated across subjects and gambles. Figure 1 shows the difference in distribution between a royalty rate of 0% and 5%, and Figure 2 shows the same for royalty rates of 0% and 20%. Notice that there is no discernable difference in Figure 1, but Figure 2 reveals a consistently higher premium above expected value for a royalty rate of 20%.

A Kolmogorov-Smirnov test rejects the null hypothesis of the equivalence of the distributions in Figure-2, but it does not reject it for Figure 1. The Wilcoxon-Mann-Whitney test fails to reject in either case. Thus, these figures provide some support for the hypothesis that the level of royalty share makes a difference that translates into a change of parameter in the expected utility model.

Insert Figure 1 and Figure 2.

Figure 3 presents the non parametric density estimation of the difference between the subjects' WTA and the expected value of the gamble, comparing safe vs. risky gambles. As we can see, the distributions are not identical and the mean of Premium is noticeably higher for risky gambles (while both means are strictly positive values). A Kolmogorov-Smirnov test rejects the null hypothesis of the identity of the distributions, as does the Wilcoxon-Mann-Whitney test.

Insert Figures 1, 2 and 3.

3.2. Parametric Estimations

We fit an expected utility model to the aggregate data using the Constant Relative Risk Aversion (CRRA) functional form, which is standard in economics experiments. The method of fit is non-linear least squares. The results are presented in Table 4. We provide two types of estimates in the table. The first row reports the regression results using our pooled data. The second row shows the mean estimate of the parameter when we fit the model subject-by-subject, using the thirty observations we have for each subject. The underlying model is provided below.

$$\boldsymbol{U}(\boldsymbol{X}) = \sum_{i=1}^{2} \boldsymbol{p}_i \frac{\mathbf{1}}{\mathbf{1}-\boldsymbol{r}} \boldsymbol{x}_i^{\mathbf{1}-\boldsymbol{r}}$$

The general conclusion that we can draw from the results reported in Table 4 is that the subjects appear to be slightly risk-loving, evident from the statistically significant negative estimated values of r.

Insert Table 4.

A simple alternative specification is to allow the parameter of the utility function to vary with the type of gamble being safe or risky as defined in this paper. We did this by splitting the sample and estimating the coefficient of relative risk aversion separately for each type of our lotteries[7]. The results are reported in Table 5 and the underlying model can be written as in below.

$$\begin{cases} \boldsymbol{If\ safe}: \quad \boldsymbol{U(X) = \sum_{i=1}^{2} p_i \frac{1}{1-r_1} x_i^{1-r_1}} \\ \boldsymbol{If\ risky}: \ \boldsymbol{U(X) = \sum_{i=1}^{2} p_i \frac{1}{1-r_2} x_i^{1-r_2}} \end{cases}$$

Insert Table 5.

The results in Table 5 show that the subjects' responses are just very slightly closer to risk-neutral in the safe gambles, while for risky gambles the estimate shows slightly more risk-loving behaviour (the parameter r turns out to be -0.035 in safe gambles versus 0.037 in risky ones). The results reported in Table 5 do not make a case, however, for a statistically significantly different behaviour across the two types of gambles.

Next, we considered the case in which the parameter of the utility function, as specified at the end of this paragraph, varied according to the type of sale. The results are presented in Table 6 where each column of the table represents the estimated parameter for each of the three different royalty rates (inclusive of 0% royalty). Again, risk-loving behaviour is exhibited in all three cases, and consistent with intuition gleaned from Table 3, the degree of risk-loving indecisions increases, which means expressing higher WTAs, with the increase in the royalty rate in accordance to our behavioural conjecture (the parameter r turns out to be -0.023; -0.032 and -0.066 in 0%; 5% and 20% royalty respectively). The underlying model is provided below.

[7] We have also estimated this model for females and males separately. We found that females are slightly less risk-loving (approximately risk-neutral) compared to males as it was also found is Eckel *et al.* (1998). The results are reported in Table 9.

$$\begin{cases} \boldsymbol{If\ Whole\ Sale}\ (\mathbf{0}\%\ \boldsymbol{royalty}): & \boldsymbol{U(X)} = \sum_{\boldsymbol{i=1}}^{\mathbf{2}} \boldsymbol{p_i} \frac{\mathbf{1}}{\mathbf{1}-\boldsymbol{r_1}} \boldsymbol{x_i}^{\mathbf{1}-\boldsymbol{r_1}} \\ \boldsymbol{If}\ \mathbf{95}\%\ \boldsymbol{Sale}\ (\mathbf{5}\%\ \boldsymbol{royalty}): & \boldsymbol{U(X)} = \sum_{\boldsymbol{i=1}}^{\mathbf{2}} \boldsymbol{p_i} \frac{\mathbf{1}}{\mathbf{1}-\boldsymbol{r_2}} \boldsymbol{x_i}^{\mathbf{1}-\boldsymbol{r_2}} \\ \boldsymbol{If}\ \mathbf{80}\%\ \boldsymbol{Sale}\ (\mathbf{20}\%\ \boldsymbol{royalty}): & \boldsymbol{U(X)} = \sum_{\boldsymbol{i=1}}^{\mathbf{2}} \boldsymbol{p_i} \frac{\mathbf{1}}{\mathbf{1}-\boldsymbol{r_3}} \boldsymbol{x_i}^{\mathbf{1}-\boldsymbol{r_3}} \end{cases}$$

Insert Table 6.

Having estimated expected utility models with an eye on differences between types of lotteries, we now turn to a non-expected utility model looking for evidence of the bias of overweighting small probabilities of good outcomes. Following Loomes *et al.* (2002), we estimated a specification based on rank-dependant utility (RDU) model. The version of the model that corresponds to our estimation is as follows.

$$\boldsymbol{EU(X)} = \sum_{\boldsymbol{i=1}}^{\mathbf{2}} \boldsymbol{p_i}(\mathbf{1}-\boldsymbol{\delta b})\frac{\mathbf{1}}{\mathbf{1}-\boldsymbol{r}}\boldsymbol{x_i}^{\mathbf{1}-\boldsymbol{r}}$$

The variable δ is a dummy that takes the value of 1 is if p_i is the smallest probability of the good outcome of the set of lotteries and zero otherwise. If $\hat{b}$=0 (estimated value of b is not statistically significantly different from zero) it indicates no bias while a negative value of $\hat{b}$ indicates that the subjects overweighed the lowest probability of the good outcome. Note that here again we estimated this model both on aggregate data and separately for each type of gambles (safe and risky). The results of the estimations are reported in Table 7.

Insert Table 7.

Two items are revealed by the results reported in the left panel of Table 7 (pooled regression). First, the estimated degree of risk-loving behaviour slightly decreases when we change from general specification to this specification (from -0.037 to -0.035) meaning that the subjects may be deemed less risk-loving if this bias in the perception of the probabilities is accounted for. Second, as it has been found in other experiments, the estimated value of b is negative (-1.184), which provides evidences for the conjecture that subjects overweigh the lowest probability of the good outcomes in deciding about the magnitude of the expected payoffs. The adjusted R^2 slightly declines as we change from the expected utility specification to the rank-dependant utility proposed by Loomes.

Looking at the right panel of Table 7, containing the split-sample estimations of the parameters r and b, we notice that the parameter b is positive for safe gambles (0.33) and the subjects are found to be more risk-loving compared to their outcome of risky gambles. This counter-intuitive result can be explained recalling that rank-dependant utility model is not an appropriate framework of analysis when the good outcome does not substantially differ from the bad outcome. This is the case with our safe gambles ($15 versus $25). We believe it is for this reason that the rank-dependant utility model does not lead to plausible values for the parameters b and r in here.

Using the rank-dependant utility framework we also treated the three types of sales (whole, 95%, 80%) as separate samples. The results are presented in Table 8. Here, we find that the differences among out three sub-samples follow the same direction as in the split-sample estimations resulting from expected utility model frameworks: we find again that as the resale royalty percentage increases the subjects become more risk-loving. The differences in the parameter b are negligible (-1.113; -1.120 and -1.121 for whole, 95%, 80% respectively). In this case as well, the adjusted R^2 slightly declines compared to the expected utility model estimations[8].

Insert Table 8.

[8] Rank dependant utility model has been estimated for male and female separately. The results of these estimations are reported in Table-10.

IV. Conclusion

Visual artists' resale royalty, recognised in the EU countries, Australia and New Zealand, creates a shared ownership of the copyrighted work's financial yield from its successive resales. In the United States and Canada, there is no federal recognition of the visual artists' resale royalty right. Examining the question of economic efficiency of this institution can contribute to the harmonisation of national laws in this matter, at least, among developed countries.

We examined the implication of resale royalty regime thorough an experiment replicating the decision making context with and without resale royalty. We modeled visual art works as lotteries. Our experiment allowed us to infer subjects' risk preferences, and to observe their behaviour under two different royalty rates. We found evidences that the setting intended to replicate resale royalty institution decreased subjects' risk aversion. The conclusion came after the observation that subjects did not discount their WTA fully in line with the size of the royalty. We also found that this effect is enhanced when there is a relatively small probability of a relatively large payoff.

This finding implies that with resale royalty institution, the number of transactions in the market for visual arts can decline. The number of transactions must be expected to decline provided that art dealers are more prone to decide in accordance with the rational choice framework and are risk-neutral. We also used a non-expected utility model to fit the experimental data, further providing evidence that the resale royalty regime induces behavioural outcomes not adequately predicted by neoclassical theory.

How might this affect the artists' welfare? Definitive answers can only be determined by further study involving both sides of the market. However, if we assume a difference in bargaining power between the artist (seller) and the dealer (buyer) and given that a fraction of artists are probably obliged to sell their work at any offer for their subsistence then the artists are not likely to be able to receive the prices they desire for their art at the time of the first sale and, this lowers their welfare. In any case, our results suggest that a resale royalty regime may leave sellers dissatisfied with the prices they receive in the market place, even if those prices would have deemed reasonable to them prior to resale royalty regime.

We believe that increasing the legal threshold of the resale price required for the applicability of the resale royalty right can limit its impact on the first sale price to the exceptionally promising artists who are likely to be the beneficiaries of the resale royalty later in their career. We believe this amendment can mitigate the above-described adverse effect of the institution on other (especially young) artists while promoting the continuation of artistic endeavours among more promising ones.

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Annex 1: Tables and Figures

Table 1.
Resale Royalty in France

Resale Price in €	Royalty %	Average Royalty
1-3.000	0	0
3.001-50.000	4	1.060
50.001-200.000	3	3.750
200.001-350.000	1	2.750
350.001-500.000	0.5	2.125
500.000 and higher	0.25	1.250 and higher

Note
The information in this table is extracted from «Code de la propriété intellectuelle, version consolidée au 1 décembre 2009».

Table 2.

Risk Neutral Predictions for the Experiment's Lotteries

	Risky Gamble ($1 or $40)			Safe Gamble ($15 or $25)		
	Royalty (%)			Royalty (%)		
Probability (Low Outcome)	0%	5%	20%	0%	5%	20%
0.1	36.10	34.30	28.88	24.00	22.80	19.20
0.3	28.30	26.89	22.64	22.00	20.90	17.60
0.5	20.50	19.48	16.40	20.00	19.00	16.00
0.7	12.70	12.07	10.16	18.00	17.10	14.40
0.9	4.90	4.66	3.92	16.00	15.20	12.80

Note :
This panel contains Expected value (WTA for a risk neutral utility maximizing agent).

Mean WTA from the Experimental Data

	Risky Gamble ($1 or $40)			Safe Gamble ($15 or $25)		
	Royalty (%)			Royalty (%)		
Probability (Low Outcome)	0%	5%	20%	0%	5%	20%
0.1	36.99	37.45	35.89	27.29	26.02	25.01
0.3	32.34	30.81	30.21	24.67	24.33	23.45
0.5	24.36	24.12	22.84	21.84	20.64	20.92
0.7	17.55	17.45	16.32	18.33	18.46	17.79
0.9	12.84	12.60	11.50	16.55	16.80	17.04

Note
This panel contains the mean WTA form the experiment with 64 subjects.

Table 3.
Mean WTA Comparison between Whole Sales and Partial Sales.

	t-statistic: Risky Gamble		t-statistic: Safe Gamble	
Probability (Low Outcome)	**0%-5%**	**0%-20%**	**0%-5%**	**0%-20%**
0.1	0.903	1.674	0.311	0.728
0.3	0.274	0.978	0.120	1.146
0.5	1.262	0.845	0.120	0.781
0.7	0.142	0.613	0.055	0.642
0.9	0.272	-0.474	0.120	0.679

Note
This table contains cross-tabulation of the t-statistics for the null hypothesis of the equality of means of the subjects' WTA as reported in lower panel of Table 2.

Table 4.
Expected Utility (CRRA) Parameter Estimates: Pooled vs. Individual

	Pooled Regression	**Individual Regressions**
Parameter *r*	-0.037** (0.002)	-0.030 (0.062)
Adjusted R^2	0.8689	---
Number of Obs.	1920	1920

Note
The indication ** means the estimate is significant at 5% level while * indicates significance at 10% level; standard errors are in parentheses below the parameters.

Table 5.
Expected Utility (CRRA) Parameter Estimates: Safe vs. Risky

	Safe Lotteries	Risky Lotteries
Parameter r_i	-0.035** (0.002)	-0.037** (0.003)
Adjusted R^2	0.9169	0.8378
Number of Obs.	960	960

Note
The indication ** means the estimate is significant at 5% level while * indicates significance at 10% level; standard errors are in parentheses below the parameters.

Table 6.
Expected Utility (CRRA) Parameter Estimates Across Royalty Rates

	0% Royalty	5% Royalty	20% Royalty
Parameter r_i	-0.023** (0.003)	-0.032** (0.003)	-0.066** (0.004)
Adjusted R^2	0.873	0.877	0.871
Number of Obs.	640	640	640

Note
The indication ** means the estimate is significant at 5% level while * indicates significance at 10% level; standard errors are in parentheses below the parameters.

Table 7.
Rank Dependant Utility Parameter Estimates

	Pooled Regression	Risky Gambles	Safe Gambles
Parameter *r*	-0.035** (0.003)	-0.032** (0.003)	-0.049** (0.003)
Parameter b	-1.184** (0.154)	-1.169** (0.154)	0.33* (0.193)
Adjusted R^2	0.826	0.784	0.899
Number of Obs.	1920	960	960

Note
The sign ** Indicates significant at 5% level; * Indicates significance at 10% level; standard errors are in parentheses below the parameters.

Table 8.
Rank Dependant Utility With Sample Split Along Royalty Rates

	0% Royalty	**5% Royalty**	**20% Royalty**
Parameter r_i	-0.022** (0.007)	-0.030** (0.003)	-0.065** (0.004)
Parameter b	-1.113** (0.247)	-1.120** (0.220)	-1.121** (0.224)
Adjusted R^2	0.831	0.833	0.829
Number of Obs.	640	640	640

Notes
The sign ** Indicates significant at 5% level; * Indicates significance at 10% level; standard errors are in parentheses below the parameters.

Table 9.
Expected Utility (CRRA) **Parameter Estimates: Female vs. Male**

	Female	**Male**
Parameter *r*	-0.029** (0.003)	-0.046** (0.003)
Adjusted R^2	0.8611	0.8885
Number of Obs.	1120	900

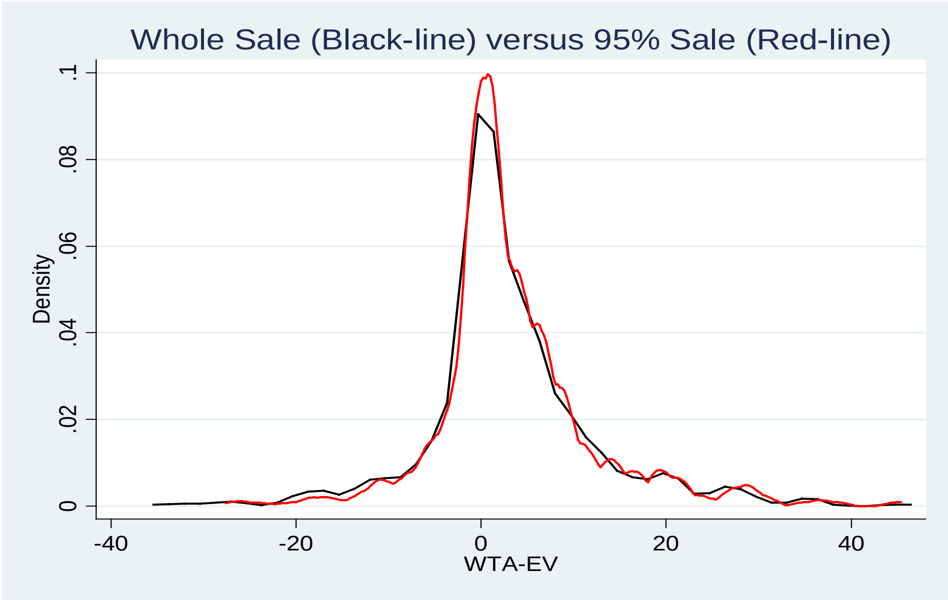
Note
The indication ** means the estimate is significant at 5% level while * indicates significance at 10% level; standard errors are in parentheses below the parameters.

Table 10.
Rank Dependant Utility Model: Female vs. Male.

Parameter	**Female**	**Male**
Parameter *r*	-0.027** (0.003)	-0.046** (0.003)
Parameter *b*	-1.131** (0.188)	-1.240** (0.213)
Obs.	1120	900
Adjusted R^2	0.8125	0.8422

Note
The indication ** means the estimate is significant at 5% level while * indicates significance at 10% level; standard errors are in parentheses below the parameters.

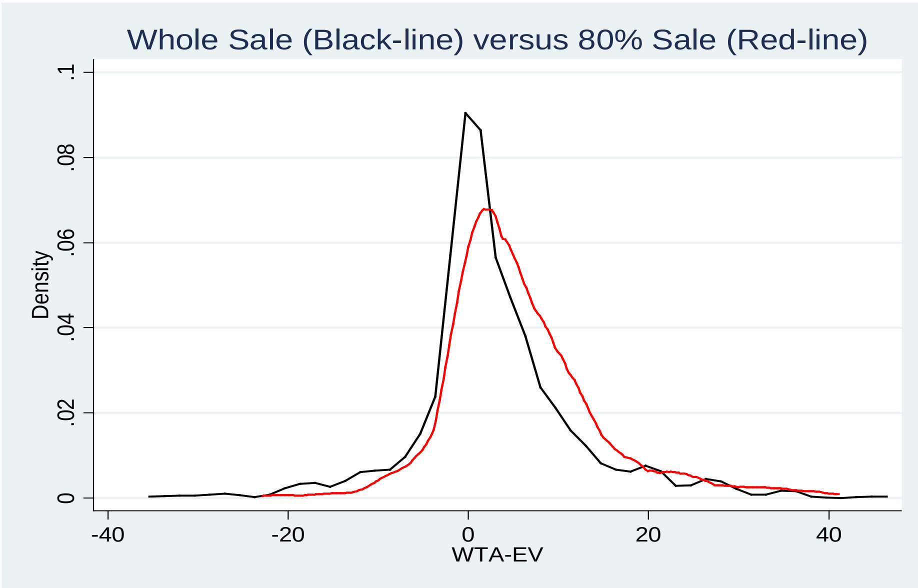
Figure 1: Difference between WTA and EV 5% Royalty



Note

K-density estimates of the subjects' WTA.

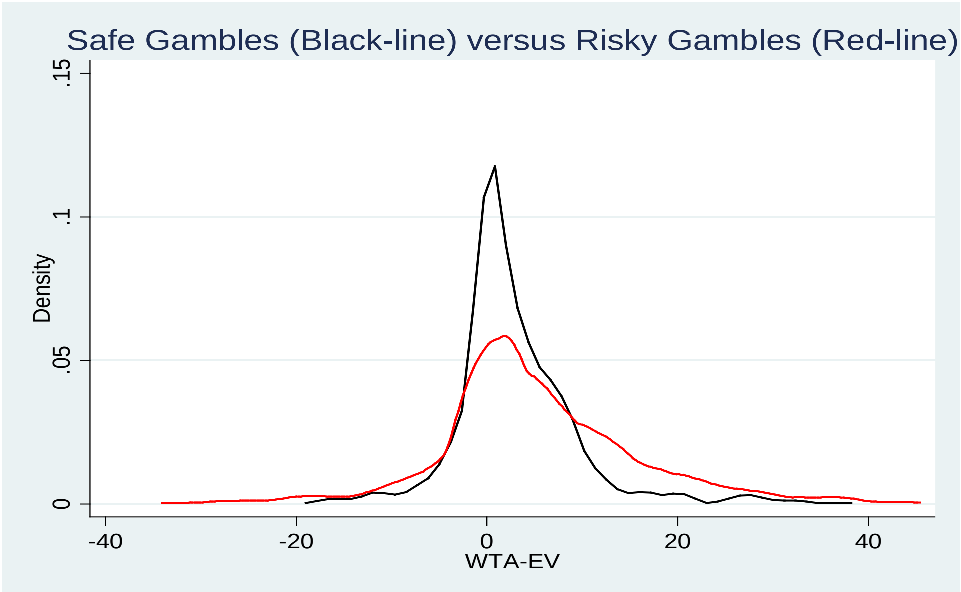
Figure 2: Difference between WTA and EV 20% Royalty



Note

K-density estimates of the subjects' WTA.

Figure 3: Difference between WTA and EV Safe vs. Risky



Note
K-density estimates of the subjects' WTA.

Annex 2: Sample of Experimental Treatment

Instructions

Welcome

Thank you for participating today!

Please turn off your mobile phones. Please do not talk during the experiment and do your own work. Please raise your hand at any time if you have a question.

What you will be doing

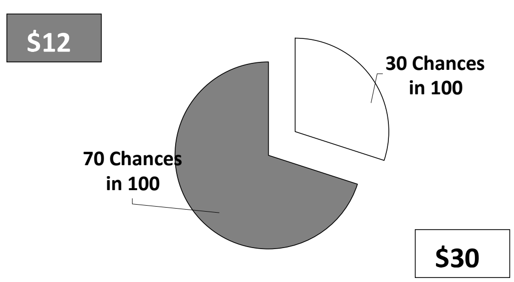
You will make several decisions involving lotteries today. The results will depend on your decisions and chance. You will be paid in cash according to the results of one of your choices at the end of the experiment. All of your decisions will be anonymous.

Describing the lotteries

In each question you will be given a lottery. This means that at the beginning of each question, you own the lottery and if nothing changes you may play it for cash.

A lottery is represented by a pie chart. The area filled in by each shade in the chart, dark or light, represents a different outcome. Each outcome is an amount of money that is paid in cash if the outcome occurs. The size of the dark and light zones represents the chances of the outcome occurring. The larger the zone, the more likely the outcome.

Please look at the example below and make sure that it is clear.



In this example, the larger dark zone represents a 70 in 100 chance of winning $12. And the smaller light zone represents 30 in 100 chances of winning $30.

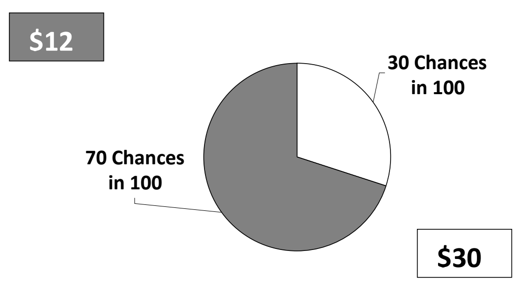
The decisions you will make:

At the start of each question you will be given a lottery. This means that at the start of each question you own the right to play the lottery for cash.

<u>The first type of decision</u>

In the first type of task you will decide the *minimum amount of money* that you are willing to accept in exchange *for the lottery*.

Please look at the following example:



=$ X

In this example the decision maker receives a lottery with a 30 in 100 chance of winning $30 and a 70 in 100 chance of winning $12.

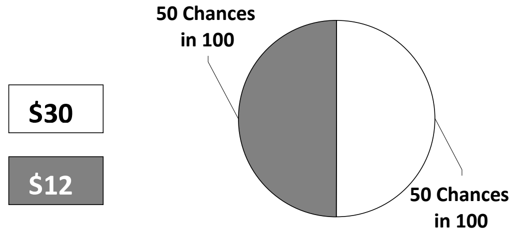
The task is to report the minimum amount of money that would be acceptable in exchange for the lottery and to record it in the place of the letter X. If the exchange were to be made the decision maker would then own the cash and none of the lottery.

Receiving an amount larger than or equal to the amount reported would be acceptable to make the exchange of the amount for the lottery. Receiving an amount smaller than the amount reported would be unacceptable to make the exchange between the amount and the lottery.

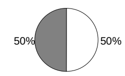
<u>The second type of decision</u>

In the second type of task you will decide the *minimum amount of money* that you are willing to accept in exchange *for part of the lottery*. After the exchange you still own a portion of the lottery.

Please look at the following example:



The Small Pie is **5%** of the original one.



=$ X +

In this example the decision maker receives a lottery with a 50 in 100 chance of winning $12 and a 50 in 100 chance of winning $30.

The task is to report the minimum amount that would be acceptable in exchange for 95% of the lottery and to record it in the place of the letter X. If the exchange were to be made the decision maker would own the cash and 5% of the lottery. 5% of the lottery is 5% of the payoffs. In this case, this would be 50 in 100 chance of winning $1.50 and a 50 in 100 chance of winning $0.60.

Receiving an amount larger than or equal to the amount reported would be acceptable to make the exchange of the amount for the lottery. Receiving an amount smaller than the amount reported would be unacceptable to make the exchange between the amount and the lottery.

The decision booklet

The booklet containing your decisions has been placed on your desk upside-down. You will make your decisions one page at a time.

(1) After the instructions are completed, turn over the top page of the booklet.
(2) Record your responses on the page.
(3) When finished, turn the page upside-down and raise your hand.
(4) An experimenter will collect your page, leaving it upside down and place it on the desk in the middle of the room.
(5) Turn over the next page and repeat this procedure.

Determining your earnings

After entering all of your decisions onto the decision sheets, there are two steps to determine your earnings.

<u>(1) One randomly selected decision</u>

First a computer will randomly determine which decision you will be paid for. Every decision has the same chances of being selected for pay.

Since every decision has the same chances of being chosen: every decision you make is equally important for your final earnings.

<u>(2) Determining whether to make the exchange</u>

Second. a number will be drawn by a computer to determine whether you play the lottery or exchange it for cash. The number will be in dollars and cents from 0.00 to 50.00. Every number from 0.00 to 50.00 will have the same chance of being drawn.

(1) If the number drawn is equal to or smaller than the number you reported as your maximum willingness to accept for your lottery then you keep the lottery and play it for pay.

(2) If the number drawn is larger than the number you reported then you exchange your lottery for the amount that was drawn and in some cases part of the lottery.

It is in your best interest to report your true willingness to pay to exchange lotteries.

This procedure is complicated but the computer uses this procedure simply so that it is in your best interest to report your true minimum willingness to accept to make the exchange.

Think of the procedure as working this way. You state a minimum asking price for your lottery say $100. If someone says “I’ll give you $75 for it” you would reply “no thanks”. But if someone says “I’ll give you $110 for it” you would reply “It’s a deal”. That is precisely how this procedure works.

It may seem as though it may be worth it to under-state your willingness to accept for an exchange but in reality doing so can only hurt you.   Here are some examples that explain why it can only hurt you to misreport your true valuation of the exchange.

Under-reporting willingness to accept:

For example imagine that your minimum willingness to accept to make the exchange is $20 but you report $10.

If the number drawn is between $10 and $20 say $15 you receive $15 and make the exchange.

Since you would have preferred to keep the lottery (you were willing to accept at least $20) reporting a lower willingness to pay was a mistake.

Over-reporting willingness to accept:

For a second example imagine that your minimum willingness to accept to exchange lotteries is $20 but you report $25.

If the number drawn is between $20 and $25 say $23 you keep the lottery and do not make the exchange.

Since you would have preferred to make the exchange (you were willing to accept at least $20) reporting a higher willingness to accept was a mistake.

Summary of your earnings

First one of your decisions will be selected to determine your earnings. All of your decisions have an equal chance of being selected. All of your decisions are equally important for your earnings.

Second the random number will be drawn to determine whether or not the exchange is made. It is in your best interest to report your true minimum amount of money you are willing to accept for each lottery.

You will either receive the lottery the cash or the cash and a portion of the lottery depending on the decision that is chosen for pay.

Collecting your earnings

After you have completed all the pages in your booklet please raise your hand. An experimenter will return all of your pages to you and instruct you where to go to collect your payment.

The specific response for which you are paid and the random number that is drawn to determine whether you keep the lottery will be determined by the computer at the payment station.

If you play the lottery for pay the outcome will be determined by drawing a coloured chip out of a bag.

Are there any questions?

Quiz

Please answer every question and then raise your hand when you are finished.

For the questions on this page imagine that you are presented with Figure A to make your decisions in the experiment.

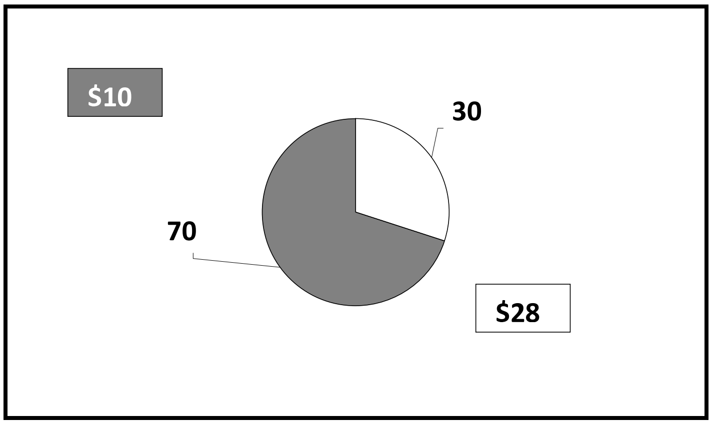


Figure A.

1. What do you have before you make your decision? How many chances do you have to win how much money?

2. Imagine that you report your minimum willingness to accept for this lottery is $30 and then the number that is drawn is $25. What do you now have?

3. Imagine that you report your minimum willingness to accept for this lottery is $30 and then the number that is drawn is $35. What do you now have?

4. Imagine that you report your minimum willingness to accept for this lottery is $30 and then the number that is drawn is $30. What do you now have?

For the questions on this page imagine that you are presented with Figure B to make your decisions in the experiment.

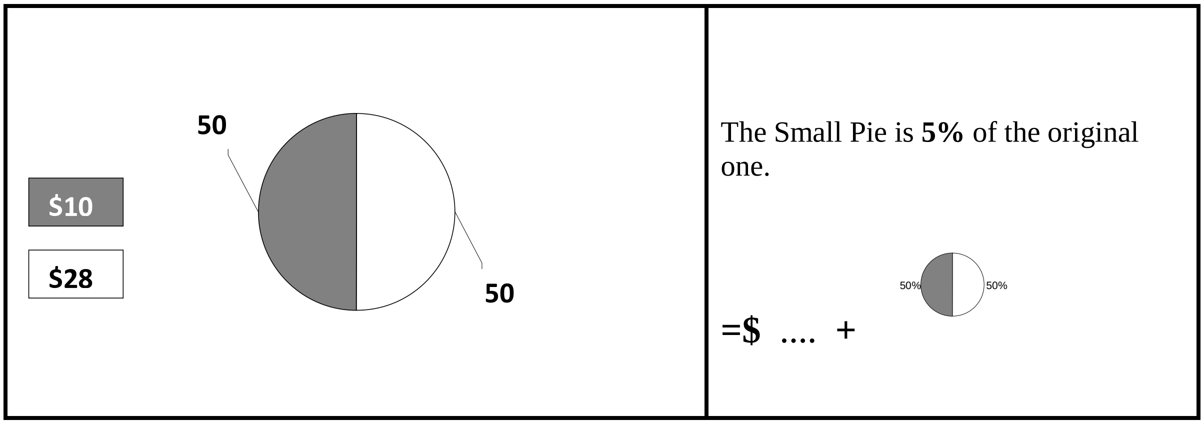


Figure B.

5. What do you have before you make your decision? How many chances do you have to win how much money?

6. Imagine that you report your minimum willingness to accept for this lottery is $30 and then the number that is drawn is $25. What do you now have?

7. Imagine that you report your minimum willingness to accept for this lottery is $30 and then the number that is drawn is $35. What do you now have?

8. Imagine that you report your minimum willingness to accept for this lottery is $30 and then the number that is drawn is $30. What do you now have?

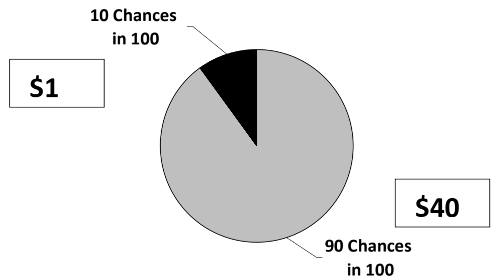
For the following question think of all the decisions you will make in this session.

9. Which decision or decisions will you be paid for and when?

Sample of the Decision-sheets

Date: **ID:**

The pie in each row of the figure below represents a **lottery that you own**. You are asked to state the **minimum amount of money** you are willing to accept for it. Please write down your response in the empty box next to the **$**. The **light zone** represents the chances of winning **$40** and the **dark zone** represents the chances of winning **$1**.

<table>
<tr><td>
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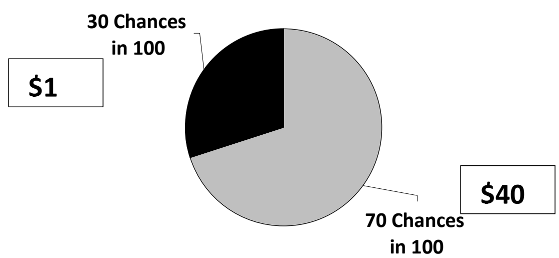
<tr><td>
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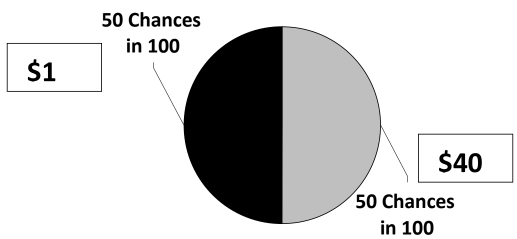
<tr><td>
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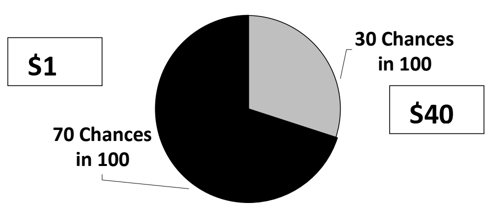
<tr><td>
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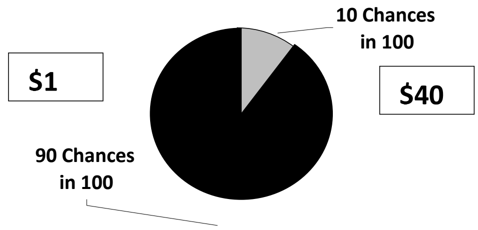
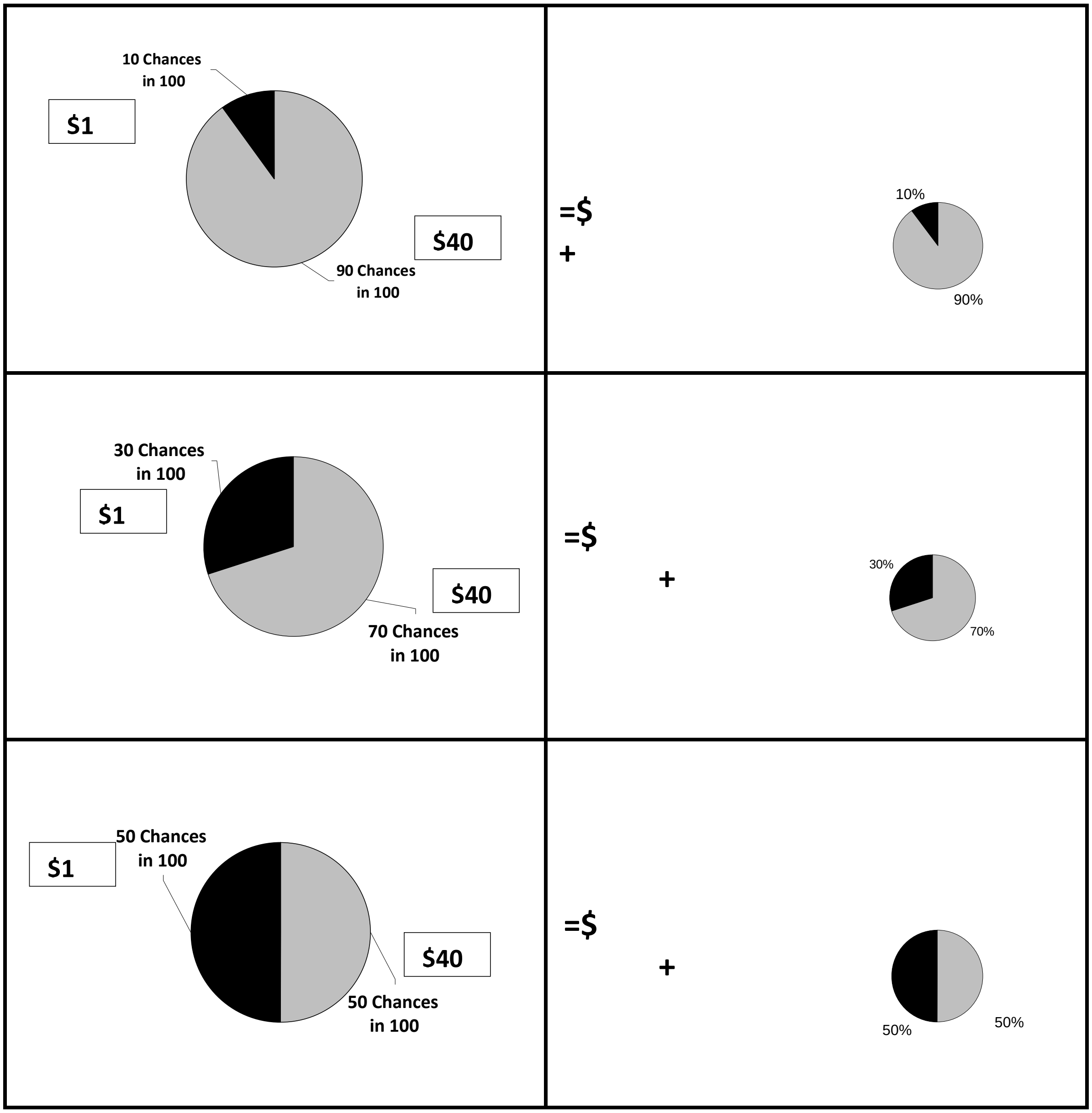
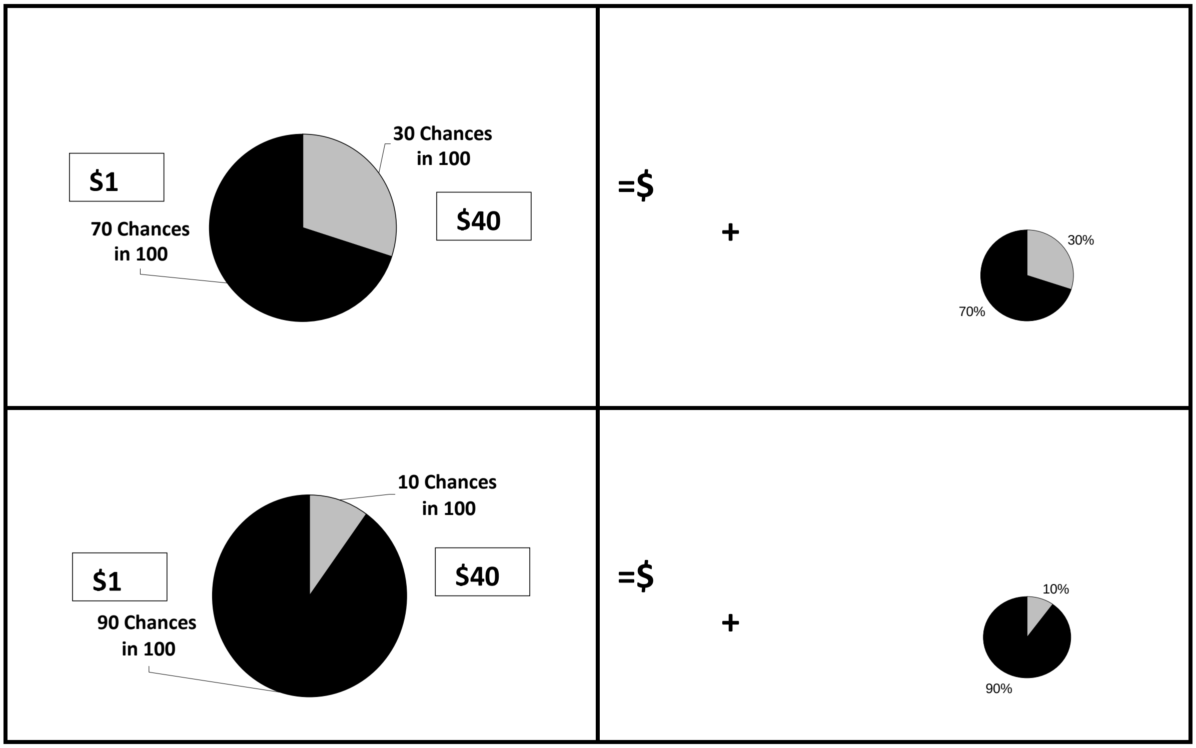
<tr><td>
</td><td>=$</td></tr>
</table>

Table 10

Date: **ID:**

The pie in each row of the figure below represents a **lottery that you own**. You are asked to state the **minimum amount of money** you are willing to accept for **80%** of it (you will be left with 20% of the original lottery). Please write down your response in the empty box next to the **$**. The **light zone** represents the chances of winning **$40** and the **dark zone** represents the chances of winning **$1**.





The inscription on the back of each sheet

1. Please write your ID in the box at the top of <u>every</u> sheet.

2. When you have finished answering the questions of this sheet raise your hand and wait for the experimenter to pick up the sheet <u>then</u> move to the next sheet.

Chapter 2

Religiosity, Human Capital and Earnings in Canada

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McGill University, Department of Economics and CIRANO

I. Introduction

Social scientists since Max Weber have been interested in the role of religion in shaping individual agents' incentives and behaviours and from there socioeconomic organization of a society. Some contemporary scholars have focused on the impact of religion through the channel of social institutions and aggregate outcomes[1], while others have examined this impact through the channel of individual behaviours[2]. In this paper, I contribute to the latter literature by studying the link between religiosity and wages in Canada, including the differential effects of religiosity by religious denomination. I also examine inter-denomination wage gap and human capital return differences.

There are various theories as to why religiosity should affect wages. One, first stated by Becker and Tomes (1979), is that religiosity, along with certain other attributes including socioeconomic status, passes on from parents to children. Religious denomination and the degree of religiosity are highly correlated among generations[3]. Children also inherit their parents' social network and financial means which affect children's wage. These two channels can lead to a correlation between religious affiliations or the degree of religiosity and earnings.

Also since religious groups have been studied as social clubs (Iannaccone 1992), it is possible to conceive of a relationship between religiosity and earnings through this channel: collective religious practice can increase an agent's social links and from there

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[1] See: Dudley and Blum 2001; McCleary and Barro 2003; Durlauf *et al.* 2006; Guiso 2003; Boppart *et al.* 2008.
[2] Azzi and Ehrenberg 1975; Ehrenberg 1977, Long and Settle 1977; Ulbrich and Wallace 1983 and 1984, and Biddle 1992; Iannaccone 1998; Inglehart and Norris 2004.
[3] In my data, among respondents with a religious affiliation, more than 87% adhere to same faith as at least one of their parents and even among respondents of no religious affiliation more than 56% follow at least one of their parents in having no religious affiliation (see Tomes, 1985, for comparable statistics).

impact his or her earnings. This channel may be especially relevant for the members of a minority religion.

Another suggestion is that religious individuals learn to be or are naturally disciplined, diligent, entrepreneurial and thrifty; values which would increase earnings[4] (Audretsch *et al.* 2007). A few recent experimental studies have found that religious individuals may also be more trusting, and therefore work more cooperatively, thereby implying that religiosity may have a positive effect on earnings[5].

There may also be a link between religiosity and educational attainment, which implies a link with earnings. This correlation is found to be positive in the United States but the direction of causality is not clear and subject to debate[6].

On the other hand, it is possible to conceive of a negative correlation between religiosity and earnings if religious individuals are also more risk-averse or conform more closely to inherited social values. The impact of a higher degree of risk-aversion and conformity on earnings depends on the society's institutions and economic organisation, and it is ultimately an empirical question. There are studies that have found a negative correlation between an individual's higher risk aversion and earnings[7]. There are also studies that have linked religiosity to Intellectual Quotient (IQ). In a cross-country study, Lynn et al. (2009) find that IQ is negatively correlated with religiosity. Assuming a positive casual relationship between IQ and labour market outcomes, one can also

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[4] Audretsch *et al.* (2007) look at the enhancing impact of religion on the tendency towards entrepreneurship with data from India. Their results suggest that certain denominations' tenets and teachings impact negatively the tendency towards entrepreneurship.

[5] Johansson-Stenman *et al.* 2006; Tan and Vogel 2006; Audretsch *et al.* 2007; Anderson *et al.* 2008. For the impact of trusting behaviour en economic attainment see: Arrow 1972; Zak and Knack 2001. Johnson-Stenman

[6] Sacerdote and Glaeser 2001; Sander 2001; Blusch 2007.

[7] See for instance Heckman et al. 2006.

conceive of a relationship between religiosity and earnings (for emotional intelligence quotient, see Len et. al 2002).

Differences in religious denominations in a given society can also overlap with the racial differences present in this society. Reitz *et al.* (2009) find that between race and religious denomination it is the former factor which has higher importance in explaining the observed labour market attainment gap among groups.

In some countries certain religious denominations are composed of mostly immigrants and the immigrant status can explain a number of variables and outcomes important in labour market. Canadian immigration policy and its requirements concerning immigrants' education may cause correlations between specific labour market outcomes and a religious affiliation with a high share of immigrants in their population. Also, since foreign labour market experience can be a poor substitute for Canadian labour market experience or its value may be unrecognized by Canadian employers[8], immigration might be behind a given religious afflation's lower attainment in the Canadian labour market.[9].

The link between religiosity and earnings may vary by religion. This variation may be because religions inculcate different values which are present more strongly in the more religious or because the selection of individuals into higher degrees of religiosity varies by religion. The implication in either case is that average earnings may also vary by religion, even controlling for observable characteristics. Examples of such values include attitudes towards education or towards family size as well as trust and cooperation.

[8] Finnie and Meng 2002.

[9] The socioeconomic impact of not adhering to the majority religion (Christianity) in Canada and the United Kingdom is the subject of a study by Model and Lin (2002).

The empirical papers examining wage gap among religious groups, regardless of degree of religiosity, find that Jews have higher earnings in the United States[10]. In Canada, Tomes (1983, 1984 and 1985) and Meng and Sentance (1984), using data from 1970s, find that Jews earn more than Catholics and Protestants conditional on observed characteristics.

Jews are usually found to have a higher education as well. It has been proposed due to their past history of the expropriation of material wealth Jews make greater investments in human capital which is embodied and transportable. The higher earnings of Jews have also been explained through their low fertility levels influencing parental investments in their children in contrast with Roman Catholics (and their religious disapproval of birth control resulting in larger family size and lower investments in each child's education)[11].

I contribute to this literature in various ways. My paper is the first to use a composite, score-based index standing for the degree of religiosity instead of a single survey question or unique observable indicator. Second, this paper is the first to consider the interaction of the degree of religiosity and religious denomination in a human capital-earnings equation. Third, I update older papers which used Canadian data to examine inter-denomination wage gap. Fourth, I consider both men and women, which previous Canadian papers did not do. Fifth, this study is the first on a high income country to consider Muslims as a distinct religious group. Sixth, I consider the interaction of the effects of religion and of immigration. I use the Ethnic Diversity Survey for my study given its questions on the respondents' religious affiliation and the extent of religiosity.

[10] Steen 1996; Chiswick 1983 and 1985; Chiswick and Huang 2006.
[11] Brenner and Kiefer 1981; Becker 1981; Tomes, 1984.

I find that higher religiosity is associated with lower earnings on average; one standard deviation increase in religiosity reduces earnings by 2.3%. This finding contrasts with results for the United States where the correlation is found to be positive. The component of religiosity that has the strongest effect is the indicator standing for the self-reported importance of religion. When I consider the effect of religiosity by religion, I find that the effect is largest for Jews (and next largest for Catholics). I find that Muslims have lower mean earnings than other denominations and no return to experience. The latter result is explained by the low return to experience for immigrants to Canada in general and the high share of immigrants among Muslims. Compared to earlier studies of Canada, my results indicate that the earnings gap for Protestants and Catholics has disappeared, but that Jews' higher mean earnings and higher return to experience remain.

II. Data

The dataset used in this study is Ethnic Diversity Survey (EDS) of Statistics Canada conducted between April and August 2002. The dataset is a survey of 41695 respondents of 15 years old and above, male or female legal residents of Canada. The advantage of this survey over labour market surveys is that it contains specific information about the self-reported importance of religion and the frequency of religious practice. The variables used in this paper are listed in Table 1 and the descriptive statistics are in Table 2. All reported statistics and estimation are computed using survey weights.

The subsample I use is the one of working respondents. EDS contains data on yearly labour earnings in Canadian dollars as well as hours worked on a weekly basis and weeks worked per year. The dependant variable, natural logarithm of hourly wage, has been created using this data. Education measured by the highest degree attained by the respondents as well as that of their parents and their spouses (if applicable) is also surveyed.

As reported in Table 3, self-reported Catholics constitute 42% of the sample followed by Protestants with 25 % and by the respondents of no religious affiliation (including but not limited to atheists[12]) with 17%. Among the minority religions, Judaism and Islam are close to each other in terms of the percentage of the devotees with slightly higher than 1% and slightly lower than 2% respectively. The average age of working Muslims (38 years old) is lower, while the average age of working Jews is noticeably higher (45 years old) than average working Canadian (41 years old). The percentage shares of immigrants in the religious groups, reported in the last column, is the highest for Muslims (95%) and the lowest for Protestants (14%).

In the EDS the respondents are asked to express their opinion about the importance of religion by ranking it from 5 to 1, where 5 stands for very important and 1 for not important at all. There are two other questions dealing with religiosity and religious activity of the respondents. In one question, the respondents are asked to choose among different options the one that corresponds to their own frequency of religious practice with a group of people of the same faith. The other question asks about the frequency of individual religious practice. For both questions the options are: at least once a week, once a month, at least three times a year, once or twice a year and not at all, taking the values of 5 to 1. In these questions of the survey "Not applicable" is also a

[12] Note that it may be difficult to distinguish between sects and groups of philosophical thoughts and some religions in the absence of a clear definition of religion. The variable "no religious affiliation" defined in Table-2 explains how this distinction is made in the EDS. It is interesting to note that this way of distinguishing between having a religious affiliation and not having a religious affiliation is in accordance with the definition proposed by Iannaccone (1998). He defines religion as "any shared set of beliefs, activities, and institutions premised upon faith in supernatural forces". His definition, he points out, excludes purely individualistic spirituality and systems of metaphysical thoughts including some variants of Buddhism.

response which is attributed to the respondents of no religious affiliation. I quantified this response by setting its value equal to zero.

For the sake of having a comprehensive measure of religiosity, an index can be defined by summing the ranking numbers of the answers to the three aforementioned questions. Note that in the first question, the respondents had to rank the importance of religion from 1 to 5 while in the two others the respondents' answers were on the frequency of their individual and collective religious practice bound by 5 predetermined categories. Therefore the index varies between 0 and 15.

Note that, this religiosity is not grounded in a theoretical framework. However, it is the most comprehensive indicator of an individual's valuation for religion given the available data in the current datasets. Moreover, an almost identical religiosity index is suggested by Statistics Canada. According to Statistics Canada, The four dimensions of religiosity, affiliation, attendance, personal practices and importance of religion-can be combined into a simple "religiosity index" constructed a manner similar to mine. A relatively high score on this index (very religious person) indicates that the individual attends religious services at least once a week, engages in personal religious practices at least once a week, and places a great deal of importance on religion (See: Clark and Schellenberg 2006).

The problematic issue in the construction of this religiosity index is that the passage from one category to the next in the questions regarding the incidence of religious practice does not signify the same distance in a quantitative way. More precisely, in the first category the reported incidence of religious practice is at least 52 times a year while in the second it falls to at least 12 times, and to 3 times in the third. Therefore the predetermined survey categories do not consistently map to a measure proportionate to the respondents' yearly frequency of religious practice.

It may be argued that any non-linear translation of categories into a quantitative measure has the disadvantage of arbitrariness. A sensible translation of surveys' predetermined categories of religious practice is used by William Sander (2002). He maps the predetermined General Social Survey categories to a quantitative measure as follows: never equals 0, less than once a year equals 0.5, about once or twice a year equals 1, several times a year equals 3, about once a month equals 12, two to three times per month equals 30, nearly every week equals 40, every week or more often equals 52.

I opt for both an *unscaled religiosity index* by summing the ranking number of the respondents to the above mentioned religion-related questions of the EDS and an index constructed in consistency with William Sander's translation of the predetermined categories into magnitudes proportionate to yearly frequencies (called *scaled religiosity index*). The scaled religiosity index is normalized to 15 and when the value of 0 is attributed to the respondents who have no religious affiliation, both indices have the same range (from 0 to 15). The scaling done, however, does not entirely solve the problem of the ordinal nature of the religiosity index, because unlike the two questions on the frequency of religious practice, no natural scale can be defined for the question about the importance of religion.

The average score of the unscaled index and scaled index is 7.7 and 5.7 respectively. Muslims rank first among the religious denominations both in the scaled and unscaled religiosity index, while Protestants' indices are the lowest among the groups. I report the means of the indices and their components in Table 4.

Descriptive statistics on the relationship between religious denomination and hourly earnings as well as educational attainment are reported in Table 5. The statistics suggest sizable differences among religious groups. Working Jewish males earn 26%

more than average working Canadian males, while working Muslims earn 13% less than the average Canadian and working Muslim males earn 15% less than the average working Canadian males[13].

Jews enjoy a higher level of education evident from both average years of schooling and the percentage of their population that holds a university (college) degree. Working Jews have on average close to 2 more years of schooling and 51% of them hold a university (college) degree against 23% of all working Canadians. Muslims also have on average 1.3 more years of schooling and their university graduate percentage is higher than the average by close to 20 percentage points. It is noteworthy that unlike in previous studies dating back to 1980s, Catholics now have the same educational attainment as Protestants (see Tomes 1984).

There are a number of other variables that I use as extra controls in my estimations of Mincerian wage regression augmented by religiosity indicators (Mincer 1974). The location of the respondents' residence is controlled for (these locations are Montréal, Toronto, Vancouver, other Metropolitan areas and non-metropolitan areas). A dummy variable is included to control for self-employment. Another dummy variable is included to control for the respondents' presence or lack of social trust. A proxy for social networking is used which equals the number of social clubs the respondents take part in. Marital status, belonging to visible minority groups, being a non-native speaker and gender are controlled for as well.

[13] Tomes (1985) noted that in Canada taking into account the Jewish female side of labour market may make a substantial difference especially with respect to Jewish earnings i.e. Jewish females, he suggested, earned less than average Canadian female to the point that it could more than compensate the Jewish males' premium. The ratio of male to female earnings is currently the highest among Jews (ratio of mean hourly wages in Canadian dollars: 29/22≈1.3) while Muslims come second (ratio of mean hourly wages in Canadian dollars: 20/17≈1.2). The Canadian average wage ratio is approximately 1.1.

III. Methodology

The equation set for uncovering the relationship between religiosity, measured using the score-based religiosity index, and earnings, measured by natural logarithm of hourly wage, can be expressed as follows:

$$ln(wage) = \beta_0 + \beta_1\ Schooling + \beta_2\ Experience + \beta_3\ Experience^2 + \vec{X}\vec{\beta} + \delta\ Religiosity\ Indicator + \varepsilon \qquad (1)$$

where $\vec{X}$ contains education in years, experience, experience squared, parents' education and dummies for female, marital status, interaction of female and marital status, immigrant, visible minority, native speaker, trusting behaviour, self-employment, social networking proxy and locations. The religiosity indicators are either the scaled or the unscaled religiosity index or their components accounted for separately.

To compare mean labour market performance of religions as groups, dummies designating each denomination are used as expressed in the equation below:

$$ln(wage) = \beta_0 + \beta_1\ Schooling + \beta_2\ Experience + \beta_3\ Experience^2 + \vec{X}\vec{\beta} + \sum_{i=1}^{5}(\delta_0^i\ I_i) + \varepsilon; \quad i=1,\dots,5 \qquad (2)$$

where dummy variables I_1 to I_5 designate each denomination (Catholic, Protestant, Jew, Muslim and Other) by taking the value of 1 for the devotees of each religion and 0 otherwise. The omitted category is the group of respondents of no religious affiliation.

In order to investigate whether the relationship between the degree of religiosity and earnings differs across religions, I estimate the equation below:

$$ln(wage) = \beta_0 + \beta_1\ Schooling + \beta_2\ Experience + \beta_3\ Experience^2 + \vec{X}\vec{\beta} + \sum_{i=1}^{5}(\delta_0^i\ I_i + \delta_1^i\ Religiosity\ Index \times I_i) + \varepsilon; \qquad i=1,\dots,5. \qquad (3)$$

I am also interested in examining the differences in return to human capital variables. An equation in which the returns to education and labour market experience have varied slopes depending on religious affiliation can be written as follows:

$$ln(wage) = \sum_{i=1}^{6}(\beta_0^i\ I_i + \beta_1^i Schooling \times I_i + \beta_2^i Experience \times I_i + \beta_3^i Experience^2 \times I_i) + \vec{X}\vec{\beta} + \varepsilon; \quad i=1,\ldots,6 \qquad (4)$$

In order to complete the analysis of the wage gap among religious groups, the Oaxaca-Blinder decomposition technique is used (Oaxaca 1973, Blinder 1973). Suppose $E(Y^{NRA})$ is the mean wage outcome of the groups of respondents of no religious affiliation and $E(Y^i)$ is that of the denomination i ($i = 1, \ldots, 5$). If we are interested in decomposing the wage gap between the respondents of no religious affiliation and religious group i, denoting the gap by R^i, we have:

$$R^i = E(Y^{NRA}) - E(Y^i) = \left[E(X^{NRA}) - E(X^i)\right]' \times \beta^* + [E(X^{NRA})' \times (\beta^{NRA} - \beta^*)] + \left[E(X^i)' \times \left(\beta^* - \beta^i\right)\right] = E + U \qquad (5)$$

In Equation (5) β^* is the vector of non-discriminatory coefficients of the wage equation. The component $E = \left[E(X^{NRA}) - E(X^i)\right]' \times \beta^*$, called “Explained” in the literature, captures the contribution of the covariates (endowments) and the intercept to the wage gap while the component $U = [E(X^{NRA})' \times (\beta^{NRA} - \beta^*)] + E(X^i)' \times (\beta^* - \beta^i)$, called “Unexplained”, captures the contribution of the coefficients of the two groups’ underlying wage function to the wage gap given the vector of non-discriminatory coefficients plus the impact of unobservable factors.

Usually the vector of non-discriminatory coefficients, β^*, is estimated as a weighted average of the two groups using the same data. One special case, called the two-fold decomposition, assigns the weight of 1 to one group and 0 to the other (Oaxaca, 1973). It means taking the coefficients of one of the two groups as the non-discriminatory one. Obviously the results of the decomposition are sensitive to the choice of the non-discriminatory coefficients. This way of decomposing the wage gap is prominent in discrimination literature and it is the approach taken in this paper. I compare the five religious groups with the respondents of non-religious affiliation so $\beta^{*} = \beta^{NRA}$ (for other proposed weight matrices see Reimers 1983, Cotton 1988, Neumark 1988 and Oaxaca and Ransom 1998). The equation behind the wage gap as estimated in this paper can be then written as follows:

$$R = E(Y^{NRA}) - E(Y^{i}) = \left[E(X^{NRA}) - E(X^{i})\right]' \times \beta^{NRA} + E(X^{i})' \times \left(\beta^{NRA} - \beta^{i}\right) \quad (6)$$

As noted by Oaxaca and Ransom (1999), an identification problem arises when the decomposition results are broken into their individual components if dummy variables are included in the equation or when a variable has no natural zero point so that its magnitude is sensitive to the scaling chosen by the researcher (see: Jones and Kelley 1984). The standard methodology produces arbitrary results for the individual contributions of dummy and categorical variables as well as the constant to the unexplained portion of the decomposition results depending on the omitted category (in case of dummies) and the scaling choice (in case of variables without natural zero point). However magnitude of the aggregate components as well as the relative contributions of the components of explained part remains intact.

A solution to the arbitrariness problem caused by variables with no natural zero point has been proposed by Gardeazabal and Ugidos (2004). The idea is to restrict the coefficients for the single categories to sum to zero which means expressing the effects as deviations from the sample average. Yun (2005) proposes a solution to the problem of dummy variables that relies on averaging out the results obtained from all possible choices of omitted categories. Thus a more convenient way to deal with variables with no natural zero point is also to estimate the group models using the usual dummy coding and then apply the solution proposed for the case of the presence of dummies by Yun (2005). In this paper, given the presence of a set of dummies and a variable in the estimated equations that has no natural zero point (Trusting behaviour), the methodology proposed by Yun (implemented in STATA by Jann, 2008) is applied. Two specifications, one reduced (including a smaller set of dummy variables) and another including all of the regressors are used for the wage gap decomposition.

The Oaxaca-Blinder decomposition estimates are reported for individual covariates and coefficients as well as their aggregate level in form of aforementioned Explained (E) and Unexplained (U) components. The reported sampling variance of the decomposition results are computed following the formula proposed by Jann (2005) producing consistent estimates for the population values of variances. This formula differs from the one proposed by Oaxaca and Ransom (1998) and the comparable one proposed by Greene (2003) in adjusting for the fact that the mean covariates used in the decomposition, $E(X^i)$ and $E(X^{NRA})$, are replaced by their sample averages so they are themselves estimators. To correct for this the standard errors are divided by the degrees of freedom $N \times (N-1)$. All the equations are estimated by OLS.

IV. Results

Table 6 shows a set of the regressions in which extra explanatory variables are gradually added starting with the unique regressor of unscaled religiosity index in the first column to the full set of explanatory variables in the fifth column. Recall that the religiosity index ranges from the value of 0 (for respondents of no religious affiliation) to 15 with the standard deviation of 5.2. The coefficient of religiosity index whose value is multiplied by 10 is reported in the first column of Table 6. It implies that an increase of one standard deviation in religiosity index is associated with a decline in hourly wage of 2.3%. The impact implied by the coefficient reported in the last column of Table 6 (the estimation incorporating the full set of regressors) reaches 3.0%. This result contrasts with the pattern uncovered in the United States where the impact of religiosity is generally found to be positive (Iannaconne 1998).

No definitive explanation can be provided for this discrepancy between Canada and the United States in the absence of comparative research. One possible reason can be the religious market structure. It is recognized that in the United States the religious market is very competitive: churches, synagogues and new religions compete for devotees (see Iannaccone 1992a and 1995). This competition positively impacts the quality of religious products attracting the portions of the population that would have probably given up religious affiliation in the absence of this quality amelioration. If the consequence of this market structure is a targeted attempt to attract the more affluent part of United States' population towards religion (motivated by their potential financial contribution) then this discrepancy in the sign of the relationship between the US and Canada can be explained.

In Table 7 I explore the relative contribution of the components of the religiosity index and the sensitivity of the results to the scaling of the index. The left panel reports regressions incorporating unscaled religiosity indicators (column 1 and 2) and the right panel includes the regressions having the scaled religiosity indicators as explanatory variables (columns 3 to 7). The first regression reported in the column (1) is the same as the one reported in the last column of Table 5. In the regression in column (2) each of the components of the religiosity index are included separately. The results reported in column (2) show that much of the negative relationship between religiosity and earnings is captured by the indicator standing for the self-reported importance of religion to the respondent (the variable *Importance of religion*). Collective religious practice, by contrast, has a positive sign. All of the coefficients controlled for are statistically significantly different from each other at 10% level.

In the third column the results of a regression in which the scaled religiosity index is used are reported. All else equal, one standard deviation change in scaled religiosity index lowers the hourly wage by 2.6 percent while the impact of unscaled religiosity index amounts to 3.0 percent.

When the scaled religiosity index is decomposed in column (4) of this table, the qualitative conclusions remain the same as the column (2). However, the coefficient on collective religious practice loses its statistical significance. The coefficients on the importance of religion and individual religious practice are statistically significantly different from each other only at 20% level. All else equal, a standard deviation change in the three components of the unscaled religiosity index, importance of religion, individual religious practice and collective religious practice, affects hourly wage by -2.3 percent, -1.4 percent and 0.3 percent respectively.

Finally, the components of religiosity index (scaled version) are added one at a time to the regressions. The results of these three regressions are reported in columns (5), (6) and (7). All of the coefficients turn out to be statistically significant and negative. The effect of one standard deviation change in importance of religion, collective religious practice and individual religious practice on hourly wage is computed to be -3.3%, -2.1% and -2.8 % respectively.

The results reported in Table 7 indicate that the impact of religiosity on earnings is better predicted by the individuals' set of beliefs rather than by their behaviour. The variable *Importance of religion* can be taken as a proxy for the unobservable belief while the two other religiosity indicators are behavioural. The stronger negative correlation of the variable *Importance of religion* may indicate that the relationship between religiosity and labour market outcomes can be better understood looking at an individual's personality traits.

In Table 8 the results obtained by the estimation of the equations (2) and (3) are reported. In the upper panel of Table 8 it becomes clear that there is no statistically significant difference between the base group (respondents of no religious affiliation) and Jews or Protestants. Muslims earn close to 15% less than the reference group while Catholics earn around 4% less all else equal.

In the lower panels of Table 8 the results obtained by the estimation of the equation (3) are reported. These results show how the degree of religiosity affects individuals within their own religious denomination. The degree of religiosity does not significantly affect earnings of Muslims and Protestants within their own group. However, for the groups of Jews, Catholics and Other, higher degrees of religiosity are associated with a negative impact on earnings, with a much more important magnitude in for Jews.

Equation (3) as well as the equation (1) are based on the assumption that the relationship between the degree of religiosity and earnings is monotonic. Chiswick and Huang (2006) found that the impact of synagogue attendance is not monotonic in an equation for Jewish males' earnings in the United States. I tested such a hypothesis by using dummy variables for each value of the religiosity indicators; however, the regressions did not lead to statistically significant coefficients suggesting linearly accounting for religiosity indicators is more fruitful.

Table 9 displays the tabulation of F-statistics for the coefficients of religiosity indicators across the columns in Table 8. When the impact of religiosity is accounted for additively (the upper panel in Table 8), the difference between Muslims and all other groups is statistically significantly different from zero. The same applies to the group "Other". With respect to the regression to uncover the impact of the degree of religiosity (lower panels in Table 8) the differences between the coefficients obtained for Jews and for Catholics with other groups are statistically significantly different from zero.

Turning to the question of the cross-religion differential in human capital return, equation (4) is the basis of estimation whose results are reported in Table 10. This equation allows the coefficients on human capital variables (education, experience and experience squared) to vary with religious affiliation. The results show that there is no significant difference in the return to education among the religious groups under consideration. My results suggest that there is a sizable statistically significant difference between the return to experience of Jews and of Muslims and other groups.

The experience-earnings profile of Jews is steeper than other groups while experience turns out to have no economically and statistically significant impact on the Muslims' earnings. An illustration of the results presented in Table 10 is provided by Figure 1 and the marginal return to experience for its three different levels (5, 10, 20 years) is computed and reported in Table 11.

The higher return to experience for Jews found in my study is in conformity with previously published results for Canadian and American labour markets. However, to my knowledge, it is the first time Muslims are accounted for in such study. The fact that a very high proportion of Muslims are immigrants and given that the return to foreign experience is practically zero in Canada may partially explain the lack of return to experience for Muslims (see Finnie and Meng, 2002). This hypothesis is investigated by allowing the return to immigrant human capital variables to differ from natives. The results are reported in Table 12 and Table 13 and Figure 2 illustrates these results. By allowing the return to immigrant experience to be different, the gap between Muslims and other groups appreciably lessens: the native Muslims earnings-experience profile is similar to that of other denominations and the differences are no longer statistically significantly different from zero except for the coefficient on the squared term of Protestants' experience. At the same time, the Jewish positive gap with other groups is slightly wider when only natives are considered.

Tables 14 to 17 contain the results of the Oaxaca-Blinder decomposition of the mean wage gaps (the two-fold decomposition). The underlying model for Table 14 (showing aggregate results) and Table 15 (showing the individual contributions of a selection of covariates) is the reduced equation that includes human capital variables and a restricted set of dummies as explanatory variables. As shown in Table 14, I find that when respondents of no religious affiliation are assumed to be the no discrimination group the largest wage gap in, absolute value, belongs to Jews (-0.186) and the second largest turns out to be that of Muslims (0.136). The highest statistically significant contribution of coefficients to the mean wage gap, denoted Unexplained in the tables, belongs to Muslims (85%) and the second largest contribution belongs to Other (71%).

Also, I find that the largest contribution of the explanatory variables to the mean wage gap, denoted Explained in the tables, belongs to Jews (69%). This point indicates that labour market treatment of Jews is the closest to that of the respondents of no religious affiliation among all the religious groups under consideration

Table 15 reports the contributions of education and experience (as well as the sum of the contributions of the remaining variables) to the mean wage gaps. Most components are statistically insignificant for both explained and unexplained portions. However education and the two terms of experience, except for Muslims and Other, remain statistically significant at 5% level for the explained portion. The contribution of experience is summed over its two terms when reported in Table 15 (and Table 17). For the explained portion the results are in accordance with how the sample averages of the groups' endowments compare to those of the group of no religious affiliation. Among the reported details for the explained portion, the largest contribution comes from education for Jews (-0.10 of a wage gap of -0.19) and then Muslims (-0.08 of a wage gap of 0.14).

In the unexplained portion, informative about the differences in the coefficients hence possible discrimination, education is found to be important in magnitude for most groups with a positive sign meaning less favourable treatments compared to the no discrimination group (no religious affiliation). The largest estimate belongs to Muslims (≈0.12 for a 0.14 overall wage gap) and the second largest belongs to Other (≈0.09 of a 0.07 wage gap) while the smallest is the estimate for Jews (≈0.01 for a -0.19 overall wage gap). The estimates for the contribution of experience to the unexplained portion are close to each other in their magnitude for the groups of Protestant, Catholic and Other (approximately 0.07, 0.06 and 0.05; being 86, -129 and 70 percents of the overall wage gaps respectively). For Muslims as well, this estimate has a positive sign however it is significantly larger (≈0.14 ; 100% of the wage gap being explained). For Jews, the estimate turns out to be relatively large but negative (≈-0.08; 42% of the wage gap being explained) meaning a better treatment compared to no discrimination group. From Table 15 it becomes also clear that the magnitude of the contributions of education, in absolute value, is always lower than that of experience except for Other.

Table 16 and Table 17 report the results of the Oaxaca-Blinder decomposition (aggregate and detailed versions respectively) of the mean wage gap using the complete set of explanatory variables (called augmented equation). Using the whole set of explanatory variables leads to comparable conclusions as of the sign and the relative contributions of the explained and unexplained portions. It is however of note that with the augmented equation, the explained portion captures a higher percentage of the mean wage gap of Jews (98% against 69%). The reverse is found for Muslims where the contribution of unexplained portion to the mean wage gap increases from 85% for the reduced equation to 94% with the augmented equation (see Table 16).

The individual contributions of a number of covariates, estimated using the augmented equation, are reported in Table 17. Here too, most estimates are statistically insignificant at an individual level while education and both terms of experience (except for Muslims and Other) remain statistically significant at 5% level for the explained portion. With the augmented equation the magnitude of the contribution of education to the unexplained portion increases in absolute value for all groups except for Jews while the largest and the second largest estimates remaining those of Muslims (≈0.13 for a 0.14 overall wage gap) and Other (≈0.10 for a 0.07 wage gap). For Jews the sign of the estimate changes to negative, meaning a better treatment compared to the no discrimination group, with a relatively large magnitude (≈ -0.08 for a -0.19 overall wage gap). The estimates for the contribution of experience fall, in absolute value, for all groups compared to the results from the reduced equation. The largest fall belongs to Muslims (from 0.14 to 0.02).

Given the above-mentioned changes in the magnitudes of the contributions of education and experience in the unexplained portion, with the augmented equation, education becomes more important than experience for all groups, conversely to the reduced equation. Among the variables aggregated and reported in the columns Others the contribution of the variable *Father's education* is the largest and statistically significant at around 15% level in both explained and unexplained portions.

Overall, these tables suggest that there may be some degree of discrimination in the Canadian labour market against Muslims as a group. However, this differentiated treatment cannot be explained by the single cause of religious affiliation as a variety of factors are simultaneously at work. Since the return to experience contributes significantly to the wage gap one is inclined to say that the immigrant status is the main reason behind Muslim's lower earnings in Canada.

V. Conclusion

Using the Canadian Ethnic Diversity Survey, I examined the relationship between religions, religiosity and earnings. With respect to the impact of overall religiosity on earnings, the relationship uncovered, although quantitatively not very large, is statistically significantly negative. This result contrasts with the results for the United States. For the first time, in this paper I have explicitly accounted for Muslims along with other religious groups previously examined in the Canadian context. The results show that their earnings are significantly lower than average, while Jews' earnings are significantly higher. More precisely, I found the experience-earnings profile of Jews is steeper than that of other denominations while Muslims' return to experience is zero. The latter result is due to the higher share of immigrants among Muslims and the zero return to foreign experience of immigrants in Canada.

Further research can focus on providing an explanation for the higher return to experience for Jews. The ramifications of religiosity and religious denominations on other socioeconomic indicators such as education, cooperation, trust and risk-taking are also of interest.

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Appendix: Tables and Figures

Table 1. Definition of Variable

Variable	Definition
Unscaled religiosity index	It is constructed as follows: Religiosity Index= Importance of religion (between 0 and 5) + Religious practice in group (between 0 and 5) + Individual religious practice (between 0 and 5).
Scaled religiosity index	It is constructed by summing the score of the importance of religion with the numbers obtained by modifying the degree of religious practice from their discrete categories to a number proportionate to the yearly frequency of practice.
Importance of religion	The EDS question is framed as: "Using a scale of 1 to 5, where 1 is not important at all and 5 is very important, how important your religion to you is?" The coverage of this question is Respondents who reported having a religion. "Not applicable" includes respondents who did not report having a religion.
Religious practice in group	The EDS question is framed as: "In the past 12 months, how often did you participate in religious activities or attend religious services or meetings with other people, other than for events such as weddings and funerals?" Not applicable" includes respondents who did not report having a religion.
Individual religious practice	The EDS question is framed as: "In the past 12 months, how often did you do religious activities on your own? This may include prayer, meditation and other forms of worship taking place at home or in any other location." Not applicable" includes respondents who did not report having a religion.
Non metropolitan area	Takes the value of 1 if the area of residence of the respondent is not a Census Metropolitan Area which is an area consisting of one or more adjacent municipalities situated around a major urban core. To form a census metropolitan area, the urban core must have a population of at least 100,000.
Metropolitan area	Dummy variables for the following Census Metropolitan Areas: Montréal, Toronto, Vancouver.
Trust	The EDS question is framed as: "Generally speaking, would you say that most people can be trusted or that you cannot be *too* careful in dealing with people?" The answers were binary.
Self employed	A dichotomous variable indicating the respondent being self-employed defined as the person who is 'self employed' earns an income directly from their own business, trade or profession, rather than being paid a specified salary or wage by an employer, EDS Guide, page. 288.
ln (wage)	Natural logarithm of the respondents' hourly wage.
ln(y)	See ln(wage)
Education	Years of schooling.
Mother's educ.	Mother's education: Measured by years of schooling.
Father's educ.	Father's education: Measured by years of schooling.

Table 1. Continued.

Experience	Potential experience (in absence of any better measure) computed by age-years of education-6. The resulting number is truncated so that the potential experience is smaller or equal 40.
Experience Sq.	Squared term of Experience
Immigrant	Not a Canadian born where Canadian born is defined as an individual either born in Canada or born outside Canada from Canadian parents.
Visible minority	A dichotomous variable taking the value of 1 for visible minority as it is defined in the Employment Equity Act "persons, other than Aboriginal peoples, who are non-Caucasian in race or non-white in colour".
Non-native speaker	A dichotomous variable taking the value of 1 for persons whose mother tongue (s) neither is (includes) French nor English.
Social networking proxy	A variable taking values of 0 to 4 standing for the number of social groups the respondent takes part.
No religious affiliation	No Religious Affiliation: It includes No religion, Agnostic, Atheist, Humanist, Personal Faith, Free Thinker, Spiritual and Other. EDS Guide, p. 87.
Catholic	It includes the following denomination: Roman Catholic, Ukrainian Catholic, Polish National Catholic Church, Other Catholic.
Protestant	Anglican, Baptist, Jehovah's Witnesses, Lutheran, Mennonite, Pentecostal, Presbyterian, United Church, Other Protestant.
Other	Other religions including Buddhism, Hinduism, Sikh, Other Eastern religions, Other Christian denominations such as Orthodox.

Table 2. Descriptive Statistics

Variable	Mean	Std. Dev	Min	Max
Religiosity index	7.7	5.2	0	15
Scaled religiosity index	5.7	5.1	0	15
Importance of religion	2.7	1.8	0	5
Religious practice in group	2.3	1.8	0	5
Scaled religious practice in groups	1.1	1.8	0	5
Individual religious practice	2.7	2.1	0	5
Scaled Individual religious practice	2.0	2.3	0	5
Hourly wage	21.0	10.8	7.7	153.8
Natural logarithm of hourly wage	2.9	0.4	2.04	5.0
Education	13.2	3.7	7	20
Mother's education	9.8	3.4	7	16
Father's education	9.8	3.6	7	16
Age	41.0	11.6	16	65
Experience	21.4	11.7	0	40
Experience squared	589.2	709.8	0	1600
Social networking proxy	0.57	0.8	0	4
University degree	0.24	---	---	---
Female	0.45	---	---	---
Married	0.54	---	---	---
Immigrant	0.22	---	---	---
Visible Minority	0.19	---	---	---
Non-official language	0.25	---	---	---
Trust	0.48	---	---	---
Self-employed	0.16	---	---	---
No religious affiliation	0.17	---	---	---
Catholic	0.41	---	---	---
Protestant	0.25	---	---	---
Jewish	0.01	---	---	---
Muslim	0.02	---	---	---
Other	0.13	---	---	---
Montréal	0.12	---	---	---
Toronto	0.17	---	---	---
Vancouver	0.07	---	---	---
Other Metropolitan areas	0.31	---	---	---
Non-metropolitan	0.33	---	---	---

Note
Sample is restricted to working respondents (N=18812). Sample weights are applied.

Table 3. Socio-demographics Indicators by Denominations

Religions	Percentage	Mean Age (Std. Dev.)	Children # (Std. Dev.)	Household Size (Std. Dev.)	Immigrant Population (%)
No religious affiliation	17	38.7 (11.3)	0.7 (1.0)	2.8 (1.3)	23
Catholic	42	41.1 (11.1)	0.9 (1.1)	3.0 (1.3)	18
Protestant	25	43.3 (11.5)	1.0 (1.1)	3.0 (1.3)	14
Jewish	1	45.6 (12.9)	0.5 (0.9)	2.9 (1.4)	39
Muslim	2	38.9 (11.2)	1.4 (1.3)	3.8 (1.4)	94
Other	13	39.2 (12.4)	0.9 (1.1)	3.2 (1.4)	39
Sample	100	41.0 (11.6)	0.9 (1.1)	3.0 (1.3)	22

Note
Sample is restricted to working respondents (N=18812). Sample weights are applied.

Table 4. Mean Religiosity Indicators by Denomination

	Importance of religion	Individual religious pra.	Collective religious pra.	Unscaled religiosity ind.	Scaled religiosity ind.
Catholic	3.3 (1.3)	3.4 (1.7)	2.8 (1.5)	9.5 (3.8)	6.9 (4.5)
Protestant	3.2 (1.4)	3.3 (1.7)	2.8 (1.5)	9.3 (4.0)	6.8 (4.8)
Jewish	3.8 (1.3)	3.1 (1.6)	3.0 (1.3)	10.0 (3.5)	6.8 (4.0)
Muslim	4.0 (1.4)	3.9 (1.6)	2.9 (1.7)	10.8 (3.8)	8.9 (4.8)
Others	3.6 (1.6)	3.6 (1.8)	3.0 (1.7)	10.2 (4.6)	8.2 (5.1)
Sample*	3.3 (1.5)	2.9 (1.6)	3.4 (1.8)	9.6 (4.3)	7.3 (4.9)

Note
Standard deviations are reported in between parentheses below means. *The sample is restricted to working religious believer respondents (N=15,094) excluding respondents of no religious affiliation.

Table 5. Denominations, Earnings and Educational Attainment

	Mean Hourly Wage in Canadian Dollars (Standard Deviation)			Human Capital	
	General	**Male**	**Female**	**Education**	**University Degree**
No relig.	21.5 (11.2)	22.3 (9.2)	19.9 (10.1)	13.6	26.2%
Catholic	20.3 (10.7)	21.4 (10.9)	18.9 (10.3)	13.2	22.3%
Protestant	21.6 (11.1)	22.6 (10.2)	20.4 (12.0)	13.2	21.3%
Jewish	25.9 (13.4)	29.0 (15.0)	22.2 (10.0)	15.4	51.4%
Muslim	19.1 (12.1)	20.2 (13.6)	16.8 (8.0)	14.5	42.9%
Other	19.9 (9.8)	21.2 (9.2)	18.0 (10.5)	12.4	24.3%
Sample	20.8 (10.9)	21.9 (10.9)	19.4 (10.8)	13.2	23.6%

Note

Standard deviations are reported in parenthesis below the means. Sample is restricted to working respondents (N=18812). Sample weights are applied. Education is in years. The column noted by Degree indicates the percentage of the respondents within the groups that has obtained a university degree.

Table 6. Earnings Function Augmented by Unscaled Religiosity Index

Dependent Variable: Natural Logarithm of Hourly Wage

Indep. Variables	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**
Unscaled relig. index×10	-0.044** (0.009)	-0.046** (0.009)	-0.071** (0.001)	-0.053** (0.009)	-0.056** (0.009)
Education	----	0.036** (0.001)	0.047** (0.001)	0.048** (0.001)	0.041** (0.002)
Mother Educ.	----	----	----	----	0.004** (0.002)
Father Educ.	----	----	----	----	0.004** (0.001)
Experience	----	----	0.024** (0.001)	0.024** (0.001)	0.022** (0.002)
Experience Sq×10000.	----	----	-3.143** (0.375)	-3.185** (0.347)	-2.946** (0.372)
Female	----	----	----	-0.123** (0.009)	-0.070** (0.014)
Constant	2.977** (0.009)	2.485** (0.022)	2.034** (0.025)	2.081** (0.031)	2.030** (0.031)
R^2	0.00	0.09	0.16	0.18	0.22

Note

Five regressions are reported in this Table. Number of observations is 18812 and sample weights are applied. Heteroskedasticity robust standard errors are reported in the parentheses below the coefficients. The sign * means 10% level of significance while ** stands for 0.05% or lower levels of significance. The estimated coefficients of Religiosity index and Experience squared are multiplied by 10 and 10000 respectively.

The set of explanatory variables are of the regression (5): education, experience, experience squared, parents' education, marital status, dummies for female, married female, immigrant, visible minority, native speaker, trusting behaviour, self-employment, social networking proxy and locations.

Table 7. Earnings Function Augmented by Religiosity Indicators
Dependent Variable: Natural Logarithm of Hourly Wage

	Unscaled		Scaled				
Indep. Variables	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**
Religiosity index×10.	-0.056** (0.009)	----	-0.064** (0.009)	----	----	----	----
Importance of rel.×10.	----	-0.211** (0.051)	----	-0.127** (0.003)	-0.177** (0.025)	----	----
Collective practice ×10.	----	0.127** (0.046)	----	0.000 (0.003)	----	-0.105** (0.027)	----
Individual practice×10.	----	-0.074** (0.035)	----	-0.062** (0.025)	----	----	-0.120** (0.020)
R^2	0.22	0.22	0.22	0.22	0.22	0.22	0.22

Note
Seven regressions are reported in the table. Number of observations is 18812 and sample weights are applied. Heteroskedasticity robust standard errors are reported in the parentheses below coefficients. The sign * means 10% level of significance while ** stands for 0.05% or lower levels of significance. The estimated coefficient of religiosity indicators are multiplied by 10.

The set of explanatory variables are: education, experience, experience squared, parents' education, marital status, dummies for female, married female, immigrant, visible minority, native speaker, trusting behaviour, self-employment and locations.

In the regressions noted by "Scaled" the frequency of religious practice both individually and in group is scaled so that the passage from one discrete category to the other maps to a proportionate yearly measure of religious practice.

Table 8. (Degree of) Religiosity and Denominations

Dependent Variable: Natural Logarithm of Hourly Wage

Denominations	Catholic	Protestant	Jewish	Muslim	Other
Denomination dummies	-0.041** (0.012)	-0.023 (0.013)	0.007 (0.034)	-0.146** (0.036)	-0.065** (0.015)
Denomination dummies × Religiosity index ×10.	-0.087** (0.020)	-0.031 (0.021)	-0.235** (0.089)	-0.004 (0.089)	-0.084** (0.025)
Denomination dummies	0.042 (0.022)	0.003 (0.023)	0.240** (0.098)	-0.117 (0.110)	0.017 (0.030)

Note

Two regressions are included in this table. The first row of the results separated by triple lines is an estimation in which only dummies for denominations are added to the regression (the omitted category is no religious affiliation). In other words in this regression the impact of degree of religiosity is not taken into account. This regression's R^2 is 0.22.

In the second regression (the two last rows of the results) the degree of religiosity by denomination is also accounted for (the omitted category is no religious affiliation): This regression included not only dummies for each denomination but also their interaction terms with unscaled religiosity index. This regression's R^2 is 0.22.

In both regressions sample weights are applied. Heteroskedasticity robust standard errors are reported in the parentheses below coefficients. The sign * means 10% level of significance while ** stands for 0.05% or lower levels of significance.

The set of explanatory variables are: education, experience, experience squared, parents' education, marital status, dummies for female, married female, immigrant, visible minority, native speaker, trusting behaviour, self-employment, social networking proxy and locations.

Table 9. F-statistics for the equality of coefficients

	F-statistics (P-value)			
	Protestant	Jew	Muslim	Other
Catholic	2.76 (0.10)	2.37 (0.12)	9.07 (0.00)	2.73 (0.10)
Protestant	----	0.86 (0.35)	12.33 (0.00)	7.84 (0.01)
Jew	----	----	11.08 (0.00)	4.63 (0.03)
Muslim	----	----	----	5.43 (0.02)
Dummies for denominations				
Catholic	1.53 (0.22)	3.81 (0.05)	2.16 (0.14)	0.37 (0.54)
Protestant	----	5.33 (0.02)	1.33 (0.25)	0.17 (0.68)
Jew	----	----	5.98 (0.01)	4.50 (0.03)
Muslim	----	-----	----	1.60 (0.21)
Religiosity Index				
Catholic	3.78 (0.05)	2.41 (0.12)	0.34 (0.56)	0.00 (0.98)
Protestant	----	4.67 (0.03)	0.00 (0.98)	0.17 (0.68)
Jew	----	----	2.40 (0.12)	2.98 (0.08)
Muslim	----	-----	----	0.35 (0.56)

Note
The first set of results, separated by triple lines, is based on the regression reported in the first row of Table 8 (including only dummies for denominations). The second set of results is based on the second regression reported in Table 8 (including interaction of unscaled religiosity index and denominations' dummies as well as dummies).

Table 10. Human Capital Returns by Denominations

Dependent Variable: Natural Logarithm of Hourly Wage

	(1)						(2)
Denomination	**No relig.**	**Catholic**	**Protestant**	**Jewish**	**Muslim**	**Other**	**All groups**
Education	0.042** (0.002)	0.041** (0.003)	0.042** (0.003)	0.043** (0.011)	0.041** (0.010)	0.037** (0.004)	0.042** (0.002)
Experience	0.025** (0.003)	0.023** (0.002)	0.020** (0.003)	0.036** (0.012)	0.009 (0.011)	0.024** (0.004)	0.023** (0.002)
Experience sq. ×10000.	-3.307** (0.858)	-3.322** (0.593)	-2.240** (0.707)	-5.328* (2.800)	0.185 (3.025)	-3.965** (0.999)	-3.057** (0.372)
Dummies	---	0.012 (0.047)	0.020 (0.055)	-0.114 (0.185)	0.016 (0.176)	0.056 (0.062)	----
Constant	1.982** (0.050)	----	----	----	----	----	1.988** (0.031)
R^2	0.22						0.22

Note

Table contains two regressions. The second regression noted by *All groups* is included for sake of comparison. Samples are restricted to working respondents (N=18812). Sample weights are applied. Heteroskedasticity robust standard errors are reported in the parentheses below coefficients. The sign * means 10% level of significance while ** stands for 0.05% or lower levels of significance. The estimated coefficient of Experience squared is multiplied by 10000.

The set of explanatory variables are: education, experience, experience squared, parents' education, marital status, dummies for female, married female, immigrant, visible minority, native speaker, trusting behaviour, self-employment, social networking proxy and locations.

Table 11. Marginal Return to Experience by Denominations

	(1)						(2)
	No relig.	**Catholic**	**Protestant**	**Jewish**	**Muslim**	**Other**	**All groups**
5 years	0.022** (0.002)	0.020** (0.002)	0.018** (0.002)	0.030** (0.009)	0.008 (0.008)	0.020** (0.003)	0.020** (0.001)
10 years	0.019** (0.002)	0.016** (0.001)	0.015** (0.002)	0.025** (0.06)	0.008 (0.006)	0.016** (0.002)	0.017** (0.001)
20 years	0.012** (0.001)	0.010** (0.001)	0.011** (0.001)	0.014** (0.003)	0.008 (0.004)	0.009** (0.001)	0.011** (0.000)

Note
The marginal returns are computed by estimates reported in Table 10 through the following:
Marginal return to years of experience = $\beta_1 \times years\ of\ experience + 2\beta_2 \times years\ of\ experience$. The second regression noted by *All groups* is included for sake of comparison.

Table 12. Human Capital Returns by Denominations & Immigrants

Dependent Variable: Natural Logarithm of Hourly Wage

Denomination	No relig.	Catholic	Protestant	Jewish	Muslim	Other	Immigrant
Education	0.044** (0.003)	0.043** (0.003)	0.044** (0.003)	0.049** (0.011)	0.048** (0.010)	0.041** (0.004)	-0.007** (0.003)
Experience	0.028** (0.003)	0.025** (0.002)	0.022** (0.003)	0.042** (0.011)	0.021* (0.012)	0.029** (0.004)	-0.015** (0.004)
Experience sq.×10000.	-3.919** (0.881)	-3.753** (0.625)	-2.583** (0.733)	-6.489** (2.725)	-2.580 (3.116)	-4.953** (1.089)	2.976** (0.843)
Denomination dummies	---	0.012 (0.047)	0.036 (0.055)	-0.180 (0.185)	-0.153 (0.176)	0.010 (0.062)	0.199** (0.060)
Constant	1.937** (0.051)	----	----	----	----	----	----
R^2	0.22						

Note
Samples are restricted to working respondents (N=18812). Sample weights are applied. Heteroskedasticity robust standard errors are reported in the parentheses below coefficients. The sign * means 10% level of significance while ** stands for 0.05% or lower levels of significance. The estimated coefficient of Experience squared is multiplied by 10000.
The set of explanatory variables are: education, experience, experience squared, parents' education, marital status, dummies for female, immigrant, visible minority, native speaker, trusting behaviour, self-employment, social networking proxy and locations.

Table 13. Marginal Return to Experience by Denominations

	No relig.	Catholic	Protestant	Jewish	Muslim	Other	Immigrants
5 years	0.024** (0.002)	0.021** (0.002)	0.019** (0.002)	0.035** (0.009)	0.019** (0.009)	0.024** (0.003)	-0.012** (0.003)
10 years	0.020** (0.002)	0.018** (0.001)	0.016** (0.002)	0.029** (0.06)	0.016** (0.006)	0.019** (0.002)	-0.009** (0.002)
20 years	0.012** (0.001)	0.010** (0.001)	0.011** (0.001)	0.016** (0.003)	0.011** (0.004)	0.009** (0.001)	-0.003** (0.001)

Note
The marginal returns are computed by estimates reported in Table 12 through the following:
Marginal return to years of experience = $\beta_1 \times years\ of\ experience + 2\beta_2 \times years\ of\ experience$.

Table 14. Oaxaca-Blinder Decomposition with *Reduced Equation*

Group	Difference	Explained	% Explained.	Unexplained	% Unexplained
Catholic	0.051** (0.013)	-0.009 (0.007)	-18	0.060** (0.012)	118
Protestant	-0.008 (0.015)	-0.034** (0.009)	425	0.026* (0.014)	-325
Jew	-0.186** (0.040)	-0.128** (0.022)	69	-0.058 (0.037)	31
Muslim	0.136** (0.038)	0.021 (0.027)	15	0.115** (0.041)	85
Other	0.072** (0.017)	0.021* (0.011)	29	0.051** (0.016)	71

Note
No religious affiliation is assumed to be the non-discriminatory category. The underlying regressions have only included education, experience, experience squared and dummies for female, native speaker, visible minority, immigrant and self-employment as explanatory variables and a constant.

Table 15. Oaxaca-Blinder Decomposition with ***Reduced Equation: Details***

		Explained			Unexplained		
Group	**Difference**	**Educ.**	**Exper.**	**Others**	**Educ.**	**Exper.**	**Others**
Catholic	0.051** (0.013)	0.017** (0.006)	-0.030	0.005	0.038 (0.051)	0.059	-0.038
Protestant	-0.008 (0.015)	0.016** (0.006)	-0.051	0.001	0.025 (0.054)	0.066	-0.066
Jew	-0.186** (0.040)	-0.104** (0.015)	-0.047	0.022	0.012 (0.168)	-0.082	0.012
Muslim	0.136** (0.038)	-0.081** (0.014)	0.013	0.090	0.115 (0.157)	0.137	-0.138
Other	0.072** (0.017)	-0.016** (0.007)	0.001	0.036	0.090 (0.065)	0.052	-0.090

Note
No religious affiliation is assumed to be the non-discriminatory category. The underlying regressions have only included education, experience, experience squared and dummies for female, native speaker, visible minority, immigrant and self-employment as explanatory variables and a constant.
The contribution of Experience is computed as the sum of the contribution of the level and the squared terms included in the regression. Both terms of the contribution of experience were statistically significant at 5% level for the Explained portion except for Muslims and Other.

Table 16. Oaxaca-Blinder Decomposition with *Augmented Equation*

Group	**Difference**	**Explained**	**% Explained.**	**Unexplained**	**% Unexplained**
Catholic	0.051** (0.013)	-0.002 (0.010)	-4	0.053** (0.014)	104
Protestant	-0.008 (0.015)	-0.050** (0.010)	625	0.042** (0.015)	-525
Jew	-0.186** (0.040)	-0.183** (0.026)	98	-0.003 (0.038)	2
Muslim	0.136** (0.038)	0.008 (0.028)	6	0.128** (0.042)	94
Other	0.072** (0.017)	0.009 (0.012)	12	0.063** (0.017)	88

Note
No religious affiliation is assumed to be the non-discriminatory category. The underlying regressions have the whole set of explanatory variables: education, experience, experience squared, parents' education, marital status, dummies for female, immigrant, visible minority, native speaker, trusting behaviour, self-employment, social networking proxy and locations.

Table 17. Oaxaca-Blinder Decomposition with *Augmented Equation: Details*

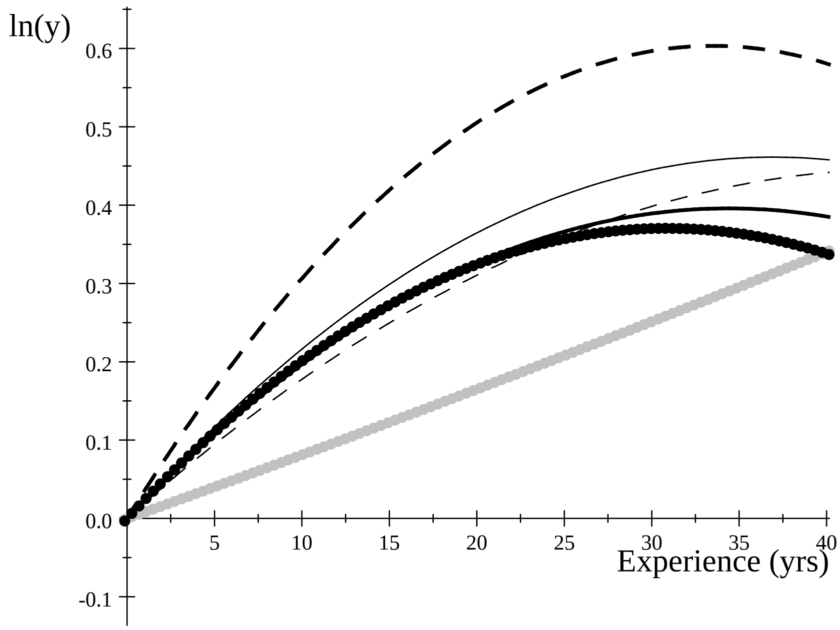
		Explained			Unexplained		
Group	**Difference**	**Educ.**	**Exper.**	**Others**	**Educ.**	**Exper.**	**Others**
Catholic	0.051** (0.013)	0.015** (0.005)	-0.026	0.010	0.050 (0.055)	0.022	-0.019
Protestant	-0.008 (0.015)	-0.014** (0.006)	-0.046	0.010	0.069 (0.058)	0.046	-0.074
Jew	-0.186** (0.041)	-0.091** (0.013)	-0.041	-0.050	-0.076 (0.165)	-0.061	0.134
Muslim	0.136** (0.038)	-0.071** (0.013)	0.011	0.068	0.128 (0.144)	0.021	-0.021
Other	0.072** (0.017)	-0.014** (0.006)	0.001	0.023	0.097 (0.070)	0.025	-0.059

Note

No religious affiliation is assumed to be the non-discriminatory category. The underlying regressions include the full set of explanatory variables: education, experience, experience squared, parents' education, marital status, dummies for female, immigrant, visible minority, native speaker, trusting behaviour, self-employment, social networking proxy and locations.

The contribution of Experience is computed as the sum of the contribution of the level and the squared terms included in the regression. Both terms of the contribution of experience were statistically significant at 5% level for the Explained portion except for Muslims and Other.

Figure 1. Return to Years of Experience by Denomination: All Sample



Legend

No religious affil.

Catholic

Protestant

Jew

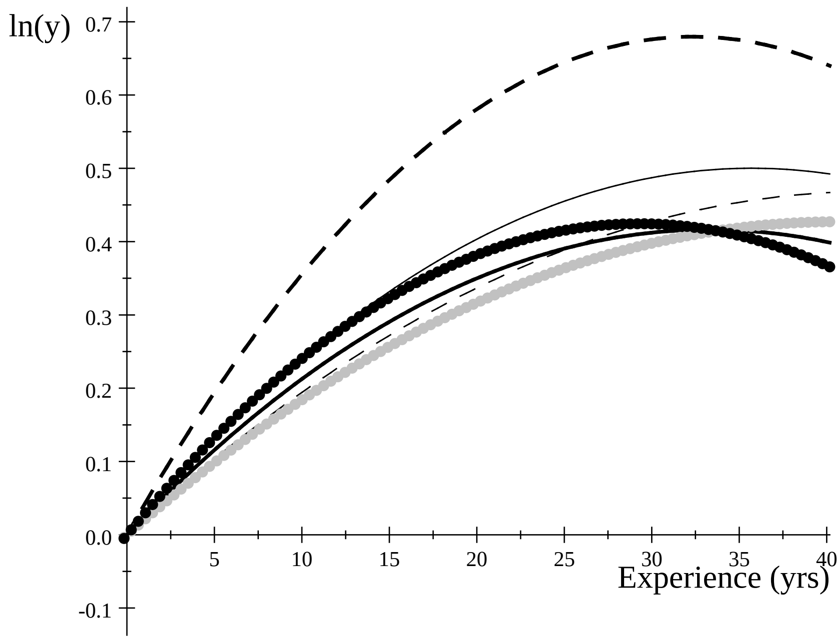
Muslim

Other

Note

The graph is based on the estimation reported in Table 10.

Figure 2. Return to Years of Experience by Denomination: Natives



Legend

No religious affil.	
Catholic	
Protestant	
Jew	
Muslim	
Other	

Note
The graph is based on the estimation reported in Table 12.

Chapter 3

Behavioural Replicator Equation: Accounting for Social Influence

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I. Introduction

This paper's objective is to put forward an equation suitable for modelling the changes in population proportion of types. Types are defined based on the heterogeneity of the agents' preferences or behavioural rules as it is the manner in economics. One of the increasingly popular ways of analytically treating this class of questions is to use the evolutionary population dynamics, termed the replicator equation. The qualitative and quantitative conclusions that stem from the replicator equation are sensitive to the specification of its fitness function. The contribution of this paper to existing literature is to propose a parametric formulation for fitness function that adequately matches mechanisms behind replication in social contexts and proposing an amended version for the equation. The proposed version is constructed by incorporating the components of social influence into its original formulation.

The replicator equation is one of the standard frameworks for evolutionary analysis. Besides its systematic use in mathematical biology with the ongoing interest in biology-inspired evolutionary approaches in social sciences, it is nowadays used by scholars of many fields with serious evolutionary inclinations or occasional evolutionary perspectives. Economic research is not an exception (for underlying debates see for instance: Andersen 1994 and 2004; Buenstorf 2006; Cordes 2006 and 2007; Foster 1997; Knudsen 2002 and 2004; Laurent and Nightingale 2001; Nelson 1995 and 2006; Witt 1999 and 2008b). The replicator equation is exceedingly used in economics in various contexts from the evolution of preferences to information propagation, learning, and in combination with game theory (see e.g. Bala and Long 2005; Cressman *et al*. 2006;

Friedman 1998; Hansson and Stewart, 1990; Noailly *et al*. 2003; Salomonsson and Weibull 2006; Samuelson 2002; Saviotti 1995).

Moreover, although not yet explicitly put forward, this equation can be used for modelling the interdependencies in economic agents' preferences and their related feedback mechanisms. In the context of consumer behaviour these interdependencies are suggested to be produced by either status-seeking or conformity and compliance with social norms in consumption that can be designated by the term social influence. Also notice that the replicator equation provides analytical means for the investigation of how a minority type of preferences may evolve into a majority type of preferences. Hence, it can be used to study the evolution of social norms, for instance how a consumption act changes from a means to signal the consumer's status to a means of conformity and norm compliance. Also, note that the above-mentioned interdependency can be extended from agents' preferences to less saliently preference-based behavioural and decision rules (see: Cole *et al.*, 1992; Fershtman and Weiss 1993; Oxoby 2004; Woersdorfer 2010).

In biological sciences, the replicator equation is used to capture the process of natural selection. Natural selection is the prevalence of a genetically inheritable trait in a population which is heterogeneous with respect to the possession of this trait after a period of time and succession of generations. The selection is due to the advantages the trait provides to the carrying individuals in reproduction or reproduction-related characteristics. The concept of natural selection is included in the replicator equation through its fitness function. However, the mathematical formulation of the equation contains such a degree of abstraction as to allow for the use of the equation in a variety of contexts only minimally analogous to the original one, since it entirely abstracts from heterosexual reproduction characteristic of animal species in its original application.

Beginning with Dawkins' proposition (1976, 1983) on the context-independence of Darwinian principles of evolution and its refinements to date, the scholarly use of this equation in social science fields has built upon viewing *inheritance* as a synonym for *social transmission* and selection resulting from a relative advantage in one type's conception compared to another type's in the context. In other words, social evolution is considered analogous to biological evolution (for the discussion of this analogy see: Witt 2004 and 2008b; Vromen 2004 and 2006; Nelson and Winter 2002). Note that social transmission is used in this paper as a broader term for learning, imitation and information propagation[1]. Given the high degree of abstraction in the equation's formulation, abstracting from heterosexual reproduction, this interpretation causes no major inconvenience. As of the fitness function, a review of economic literature making use of the replicator equation shows that rational choice related variables such as relative prices or game theoretical payoffs are used.

However, given that social transmission designates propagation mechanisms that, in principle, do not result from rational choice or rational decision making the previous uses of the replicator equation create a mismatch between fitness functions and the replication processes. This mismatch not only impairs the conceptual legitimacy of the use of the equation but also can lead to implausible conclusions. So far in the literature, no adequate attention has been paid to the conceptual legitimacy of combining the assumption of replication of traits in social issues (social transmission), which is by construction a mechanism parallel to the rational decision making, and rational choice

[1] There are also the examples of the use of replicator equation in which the original interpretation of replication, inheritance, has been implicitly or explicitly used. This conception is however debatable and cannot be generalised to cover all possible forms of social evolution: it is often observed that preferences and behavioural rules evolve in very short periods of time without any succession of generations. In this paper, I focus on the latter cases i.e. I assume that social transmission occurs independent from the succession of generations.

related fitness functions (e.g. relative price) routinely used. In fact, usually the need for a richer dynamics pattern (e.g. period-cycles and chaos) that cannot be achieved otherwise motivates researchers to use the replicator equation.

In this paper first, I discuss the above-mentioned mismatch from the vantage point of the legitimacy of using the replicator equation to model the evolution of preferences, beliefs and social norms in human societies. I argue that the use of the original version of the replicator equation not only lacks a strong conceptual legitimacy as a result of the imperfection of the analogy between human societies and biological systems but also it may produce misleading conclusions. Second, I propose remedying this shortcoming by integrating into the original version of the equation psychological the factors that regulate societal evolution through *social influence*. More precisely, I propose a fitness function that is adjusted to the specificities of social transmission mechanisms by incorporating the components of social influence into the equation. The components of social influence are consistently suggested, in the literature of all related fields, to be conformity and status-seeking. In my proposition, they are specified in terms of population proportions leaving the analytical tractability of the equation intact.

The remainder of the paper is organized in three consecutive sections. Section II builds into my proposed version of the replicator equation after reviewing its behavioural and psychological justifications. In the following section I derive the main patterns resulting from the proposed version of the equation. The last section contains some concluding remarks and suggests some applications.

II. Introducing Behavioural Replicator Equation

This section begins with an introduction to the original formulation of the equation and builds, through a few steps, into the behavioural version.

II. 1. Original Formulation

Suppose a population normalized at 1 and composed of two types: *A* and *B*. The proportion of type *A* at period t is denoted by x_t while the proportion of type *B* in the same period is denoted by $1 - x_t$. The one-dimensional discrete time formulation of the replicator equation is then $x_{t+1} = \frac{x_t}{x_t + (1-x_t)\Phi(x_t)}$ where $\Phi(x_t)$ is the fitness function. Fitness function summarizes the factors affecting the rate of replication of the type designated by x_t compared to the other type, designated by $(1 - x_t)$. If $\Phi(x_t) = 1$ then we have $x_{t+1} = x_t = \hat{x}$; in other words the system is at a fixed point.

Insert Figure 1 in here.

The shape of the equation and as a result its predictions, are very sensitive to the specification of the fitness function $\Phi(x_t)$. The equation for a constant fitness greater than 1 is depicted above for the sake of illustration[2]. There are two fixed points, 0 and 1, meaning the population at the steady states will be homogenous (either of type *A* or of type *B*). This illustration shows that for any initial proportion of type *A* smaller than 1 the population proportion of this type converges to 0 i.e., type *A* will become extinct over time.

Fitness can occasionally be assumed to be a constant; more frequently it needs to vary with population proportion of types. Typically when the number of parameters involved

[2] The plotted equation is $= \frac{x_t}{x_t + 3(1-x_t)}$.

in the specification of fitness function is greater than 4 no analytical solution can be found for the fixed points. Below, there is the illustration of a dynamically richer system[3].

Insert Figure 2 in here.

Higher degrees of fitness function with respect to the variable x_t can generate the whole set of complex dynamic behaviour, i.e., period cycles and chaos. This property proves the potential of the replicator equation for the analytical investigation of time-trajectories and fixed points of various socioeconomic issues reducible to the evolving proportion of types. However, it is also the pitfall of the equation as it calls for high precaution in applications: this sensitivity of the predictions to both the specification of fitness functions as well as parameter values makes the use of the equation for applied matters challenging.

II. 2. Criticism of Previous Applications

As it was explained in the introduction, the use of the replicator equation for modelling socioeconomic evolutions (of preferences, behavioural rules and beliefs) mainly relies on the re-interpretation of biological inheritance to social transmission. Social transmission is either imitation (see e.g. Alós-Ferrer 2003; Boyd and Richardson 1985; Cubitt and Sugden 1998; Hofbauer and Schlag 2001; Schlag 1998; Schnedler 2004) or learning (see e.g. Beggs 2005; Börgers and Sarin 1997; Hopkins and Posch 2005; Sasaki 2005; Witt 2008a). This conception of economic agents' behaviour is at variance with the rational choice framework from a number of stand points. Thus, the replicator equation is more suited to be used when the researcher decides that the rational choice framework provides an inadequate description of the question under consideration.

[3] The plotted equation is $x_{t+1} = \frac{x_t}{x_t+(1-x_t)(2x_t+0.4)^{-1}}$; $\Phi(x_t) = (\alpha x_t + \beta)^{-1}$ with equation α=2 and β=0.4.

First, in the case of modelling the evolution of preferences the use of the replicator equation implies that the preferences of individual agents are changing. However preferences are assumed to be stable in neoclassical economic theory[4]. Recent literature however, contains alternative conceptions such as endogenous preferences, discovered preferences and constructed preferences (see for instance: Bowles 1998, Bowles and Gintis 2001, Braga and Starmer 2005). This strand of literature is compatible with my conception in this paper. Mainly, this paper assumes the accuracy of these alternative views about the structure of human preferences. However, this paper addresses the population-wide consequences of social influence given the possibility that preferences evolve.

Second, the use of replicator equation implies that agents replicate others' behavioural rules or preferences instead of deciding rationally. This is also at variance with the conceptions regularly used in neoclassical economic theory. Third, utility function in neoclassical economic theory summarises human motivations by capturing the ophelimity, i.e., the power to give satisfaction. However, it has been debated that not all of the human incentives of economic impact can be represented through regular utility functions for various reasons (see e.g. Bayer *et al*. 2005). The replication (social transmission) of preferences is one of such cases, since in these contexts preferences become interdependent or frequency dependent (see e.g. Abel 1990; Bruegger 2005; Witt 1989; Hatfield *et al*. 1993). This interdependence, problematic for the axiomatic version of neoclassical utilitarianism, is compatible with the replicator equation that replaces representative agent reasoning with population reasoning. For these reasons, I believe, it

[4] For instance we read in Harrod (1938): "*The method of procedure is to take certain elements of the structure as given – namely the preference lists of individuals for goods and services*"; and in Becker (1976) we find: "*[P]references are assumed not to change substantially over time*".

is at least conceptually questionable to combine the replicator equation with rational choice related variables such as relative price. More argument follows.

In evolutionary biology fitness function is the way to capture the forces behind natural selection. Natural selection comes from the observation that the existence of natural constraints ultimately favours one type (identified through a distinctive inheritable trait) compared to another in reproduction-related matters, leading to that type's increasing proportion overtime after the succession of generations. In social matters, likewise, there are forces that intervene and determine the pattern of growth (replication) of one type of preferences, behavioural rules or beliefs compared to the other(s). These forces that stand behind the relative advantage of a type must inherently relate to the concept of social transmission so that the use of the replicator equation in social contexts remains consistent with its design. Therefore, like in evolutionary biology, the fitness function needs to capture the relative impact of the distinctive trait under consideration on the success in replication. This is not exactly the case with rational choice related signals such as relative price or interest rate that are used in economics to stand for fitness function. These variables surely affect the agents' behaviour but not through replication: their channel of impact is rational decision making. The mere assumption of replication as means of evolution in socioeconomic contexts implies, by construction, the existence of forces parallel to rational choice signals that affect individual agents. Thus, I believe, using rational signals as mechanisms behind trait selection along social transmission make an incoherent couple.

Moreover, if other social factors that affect replication in human societies (social transmission) are overlooked the predictions of the replicator equation become unrealistic in a wide range of contexts. For instance it becomes impossible to model frequently observed outcomes in human societies in which behavioural patterns or preferences that have dominated payoffs do not disappear (e.g. altruistic and other-regarding behaviours). In fact, we even observe that they may reach the status of majority or even become the consensus in a society. Or it becomes impossible to conceive any change in the proportion of types of behaviours and preferences that do not procure any gain or loss (*fitness neutral* traits in evolutionary terms). All else equal, if the prices of two goods are the same the population proportion of types of preferences should *a priori* remain constant; however we observe that it is not necessarily the case in human societies.

I end this discussion with an example. For instance a lower relative price increases the number of consumers of a given good in its own right, in a way (that should be seen as) independent from social transmission (as I will explain below, mediated by social influence). But if we intend to model the dynamic pattern of consumption not only as a result of a lower relative price but also as a result of the impression that the consumption of this good creates in peers or as a results of the high level of advertisement, then the recourse to the replicator equation is legitimate: the assumption of social transmission (of preferences in this instance) is plausible. However, a relevant fitness function cannot be (uniquely) comprised of the relative price of the good (resulting for general equilibrium hence usual utility maximization) but also the forces that made for the possibility of social transmission. It means in this example, accounting for what made the impression created by the consumption of this good or the advertisement for it of an impact on the pattern of consumption. These factors to account for, I believe, are the components of social influence.

II. 3. The Components of Social Influence

The proposed version of the equation results from the introduction of the components of social influence into the fitness function. Following Akerlof (1997) and Akerlof and Kranton (2000) I set status-seeking (the attraction of minority in abstract terms) and conformity (the attraction of majority in abstract terms) as the forces behind the dynamics of social influence in human societies.

Social influence, conceived in a way compatible way the above, is also receiving a great deal of attention particularly in empirical and theoretical literature axed on consumer identity and its impact on consumption behaviour (for an exhaustive examination of this question see: Saad 2007; see also: Do and Long 2008; Woersdorfer 2010).

Conformity is defined as a process by which people's beliefs or behaviours are influenced by others within a group. People can be influenced through subtle, even unconscious processes, or by direct peer pressure. Conformity is a group behaviour and influences the formation and maintenance of social norms and beliefs (see: Aronson *et al*. 2005; Baron *et al*. 1996; Bisin and Verdier 2000; Bernheim, 1994; Boyd and Richardson 1985; Cialdini and Trost 1998; Henrich and Boyd 2001; Jones 1984; Latane 1981).

The other part of our social influence conception as a motivation of behaviour in general, status-seeking, has been suggested by many scholars as well. Status–seeking has been advanced either independently from or alongside conformity (see e.g. Baron *et al*. 1996; Becker 1991; Becker and Murphy 2000; Brekke *et al*. 2003; Dosi *et al*. 1994). The concept of status-seeking is set next to compliance with social norms (conformity) as motivation behind certain kinds of consumption decisions as well (Leibenstein 1950; Bernheim 1994; Frank 1989 and 1999).

The economic literature on the link between social influence and consumer behavior (inclusive of the question of interdependence or complementarity of preferences) is also rich. And here too, social influence itself, is decomposed to status-seeking and conformity. For instance we read in Woersdorfer (2010): “Interdependencies in consumer behavior stem from either status-seeking consumption or compliance with social norms.”

Starting with Velben’s seminal work (1899), there is a wide range of articles on the impact of status-seeking motivations on consumption patterns using different methodology. The earliest study of the impact of status-seeking on economic outcomes, using a formal framework, is that of Duesenberry (1949). Abel (1990) and Hopkins and Kornienko (2004) are more recent formal conceptions; while the former considers status-seeking in a dynamic framework, the latter makes use of a game theoretical approach to tangle this question. Empirically, the pioneering work of Richard Easterlin (1974) is of note. The consequence of status-seeking, measured by the impact of income inequality on subjective well-being, is also considered by Clark (2003) and Alesina *et al.* (2003) among others.

In addition, I postulate that the two factors of conformity and status-seeking are affected in their magnitude by a third factor, *organized social support*. In my conception, *organized social support* includes institutions and organizations, publicity, advertisement, lobbying and the like. In the next subsection, I propose an analytically tractable way to mathematically capture all the components of social influence (conformity, status-seeking and organised social support).

II. 4. Proposed Version

I propose the following mathematical form for the relative payoff resulting from social influence: $g(x_t - 1/2)^2$ where x_t is the proportion of the agents carrying the preference trait, belief or behaviour under consideration at period t and the parameter g stands for the aforementioned organized social support.

The expression $(x_t - 1/2)^2$ is set to capture the two symmetric tendencies toward conformity and status-seeking: as the proportion of the agents carrying a given preference type, decision rule or behavioural rule gets close to 1 the payoff of (incentive for) adopting it increases, reaching a maximum at 1 which means the payoff (hence the motivation) for the remaining individuals to follow the rest of society increases until it achieves the status of common consensus (standing in this paper for fixed point equal 1 as an alternative designation). On the other hand when the trait is shared by a small portion of the society the payoff is high as a result of status-seeking.

The parameter g is a multiplier to capture what I called organized social support for the trait under consideration in the previous subsection. For instance if a given preference type, belief or behavioural rule receives considerable media attention or regular support from an established social organization or lobbyists, then the impact of the two primary components of social influence conformity and status seeking increase in magnitude by this multiplier. The social influence payoff function is graphed below for two different magnitudes of the parameter g. Notice that it is sensible to assume that the parameter g is a real number greater than unity and this range is assumed throughout this paper[5].

[5] Plotted equations: $g(x_t - 1/2)^2$ for g=10 (dashed line) and g=50 (solid line).

Insert Figure 3 in here.

It is plausible to assume that the payoffs stemming from social influence are only part of the incentives motivating an agent to adopt a given trait (type of preferences or behavioural rule). Therefore, to complete the fitness function I add physical payoff, $f(x_t)$, to the fitness function. Physical payoff stands for the tangible advantage of the trait under consideration. Concretely, it can be replaced by relative price or interest rate or the ratio of payoffs in game theoretical settings. Putting the payoffs from social influence together with the physical payoff, the fitness function becomes $\Phi(x_t) = \frac{1}{f(x_t) + g(x_t - \frac{1}{2})^2}$ and the complete motion equation, that I term *Behavioural Replicator Equation*, becomes: $\Upsilon(x_t) = x_{t+1} = \frac{x_t}{x_t + (1-x_t)\frac{1}{f(x_t) + g(x_t - \frac{1}{2})^2}}$

Insert Figure 4 in here.

The behavioural replicator dynamics is a non-linear difference equation of second degree with respect to x_t, where x_t is the proportion of the individuals with the trait under consideration at time *t*. The figure in the above is the graph of the equation with some arbitrary function for $f(x_t)$ and an arbitrary value for parameter g for the sake of illustration[6].

A simplifying case is when *f* is a constant, in which case the equation will have two parameters (*f* and *g*). And we have:

$$\frac{\partial \Upsilon(x_t)}{\partial g} = \frac{\partial}{\partial g}\left[\frac{x_t}{x_t + (1-x_t)\frac{1}{1+g(x_t-1/2)^2}}\right] = x\left(x - \frac{1}{2}\right)\frac{(1-x)}{(gx^3 - gx^2 + \frac{1}{4g} + 1)^2} \geq 0 \quad \forall x \in [0,1]$$

$$\frac{\partial \Upsilon(x_t)}{\partial f} = \frac{\partial}{\partial f}\left[\frac{x_t}{x_t + (1-x_t)\frac{1}{f+g(x_t-1/2)^2}}\right] = \frac{x(1-x)}{(gx^3 - gx^2 - x - fx + \frac{1}{4g} + 1)^2} \geq 0 \quad \forall x \in [0,1]$$

[6] Plotted equation is for $f(x_t) = \frac{7}{10}\, x_t$ and $g = 30$.

The above differentiations show that the proportion of the individuals with the trait at the basis of the definition of types is an increasing function of f (physical payoff) and, it is also an increasing function of g (multiplier of organized social support). A more detailed analysis of the equation, enumerating its resulting dynamic patterns, is presented in the next section.

III. Possible Patterns

I begin with formally defining the key terms I use, and then I take on the task of analyzing dynamic behaviour of the equation as well as the classification of its main patterns as a function of parameter values.

Definition 1. Type-attribute is the feature with respect to which the population is heterogeneous.

The proportion x_t denotes the agents carrying the type-attribute under consideration while $(1 - x_t)$ captures the complementary proportion of the population that is normalized to 1. Natural selection relies on the reproduction-related advantages of a *trait* with respect to which the population is heterogeneous. In the remainder of this paper, I replace the term “trait” by *type-attribute* to focus on the decision making consequences of the heterogeneity in the population as it is conceived in economic theory in its most general and abstract way.

Definition 2. A type-attribute is said to be *fitness neutral* if it does not procure an actual advantage or cause an actual disadvantage to the agents endowed with it or adopting it subsequently. The physical payoff function $f(x_t)$ is reduced in this case to a constant equal unity.

Definition 3. A type-attribute is said to be unfit if it causes an actual disadvantage to the agents endowed with it or adopting it subsequently. The physical payoff function $f(x_t)$ is reduced in this case to a constant smaller then unity.

III. 1. General Behaviour and Time Trajectories

Finding the possible patterns without any explicit assumption about the function $f(x_t)$ is impossible. But also, making assumptions about $f(x_t)$ without assuming a concrete context has little to offer to both an intuitive understanding of the equation and its applications, while causing important mathematical complications. I therefore focus on the special case where this function is a strictly positive constant denoted f. The behavioural replicator equation then can be written as:

$$\Upsilon(x_t) = x_{t+1} = \frac{x_t}{x_t + (1-x_t)\frac{1}{f+g(x_t-\frac{1}{2})^2}}$$

This version of the equation has only two parameters involved: f and g. A number of propositions aimed at classifying the main patterns as a function of these two parameters follow.

Proposition 1. The behavioural replicator equation can be hill-shaped.

Proof. See Annex 1.

This proposition is of interest as hill-shaped recurrence equations are susceptible to produce complex dynamic behaviour.

Proposition 2. For all values of g and any initial condition the proportion of the agents carrying the type-attribute under consideration will not decrease unless the parameter f is a constant smaller than unity.

Proof. See Annex 1.

Corollary 2.1. For all values of g and any initial condition, complex dynamic behaviour may emerge if and only if the type-attribute under consideration is unfit.

Proof. Directly follows from Proposition 2. For the proof of Proposition 2 see Annex 1. The graph below provides an illustration[7].

Insert Figure 5 in here.

Proposition 2 postulates that although behavioural replicator equation can be hill-shaped and incorporate increasing and decreasing portions, possible time trajectories of the variable x_t (the proportion of the agents carrying the type-attribute under consideration) are quite independent from the shape of the equation, but merely relate to the value of a single parameter f.

Proposition 2 is partially intuitive as we expect that unfit type-attributes extinguish over time. However, it is also implied by Proposition 2 that this may not always be the case for unfit type-attributes, and it is certainly not the case with fitness neutral type-attributes. The negation of Proposition 2 is that when f is greater or equal to unity the proportion of the agents carrying the type-attribute under consideration can only increase or remain constant. It also implies that *a priori* we cannot exclude the possibility of convergence to common consensus for any of the categories of type-attributes.

This result is interesting, as conventional wisdom and previous formal analysis lead to the conclusion that if a trait is a relative disadvantage to the carrying individual or it benefits other agents along with the carrying individual (i.e., the trait motivates free-riding or simply generates positive externality) the trait will become extinct over time.

[7] Plotted equation is for $f(x_t) = \frac{7}{10}$ and $g = 65$.

However, there are examples of many behavioural traits that constitute disadvantages in this sense and yet observations show that they may reach the status of common consensus in human societies. Participation in wars, altruistic behaviour, engaging in social activism with common benefits and philanthropic activities are obvious examples.

III. 2. Fitness Neutral Case

I will concentrate on fitness neutral type-attributes for they cover a large class of real life cases where there is no rational reason (relative advantage) underlying the (dominant) position of a belief, preference types or behavioural rule. It turns out that this class of type-attributes ($f = 1$) generates an intuitively appealing dynamic behaviour.

In contemporary human societies fitness neutrality stands behind a considerable subset of type-attributes (inclusive of preferences, beliefs, and behavioural rules) that we observe. For example, taking the consumption choice of two perfectly substitute goods with equal prices: it is implausible to think this decision can affect the person's fitness. Also, getting a medical degree as opposed to studying finance is unlikely to affect the social fitness of the individual by itself in a significant way these days (while having medical knowledge centuries ago could possibly have had some impact on the individual's fitness). In any case, as soon as the value of the physical payoff (conceived as relative price or ratio of game theoretical payoffs or else) is equal unity the type-attribute is said to be fitness neutral.

This version of the behavioural replicator equation is then $\Upsilon(x_t) = x_{t+1} = \frac{x_t}{x_t+(1-x_t)\frac{1}{1+g(x_t-0.5)^2}}$ where $\frac{1}{1+g(x_t-0.5)^2}$ is the overall fitness of the type-attribute under consideration after having replaced the parameter f with unity. The unique parameter is now g, the multiplier of the social influence payoff standing as a proxy for the organized social support. Notice that if g is equal 0 then we have $x_{t+1} = x_t = \hat{x}$; in other words there will be no change as it would result from the conceptions using rational choice framework. I have excluded this possibility by restricting the parameter g to real numbers greater than unity.

Proposition 3. The curve resulting from the equation of a fitness neutral type-attribute can be hill-shaped.

Proof. See Annex 1.

The Proposition is a special case of Proposition 1. The graph below provides an illustration with an arbitrary value for the parameter g[8].

Insert Figure 6 in here.

Proposition 4. For all values of g and any initial condition, the proportion of the agents carrying a fitness neutral type-attribute will never decrease.

Corollary 4.1. Period cycles or complex dynamic behaviour cannot emerge if the type-attribute is fitness neutral.

Proof. Directly follows from Proposition 4. For the proof of Proposition 4 see Annex 1.

Proposition 5. For a fitness neutral type-attribute there are three fixed points $\left\{0, \frac{1}{2}, 1\right\}$. The fixed points 0 and 1 are stable while and the fixed point $\frac{1}{2}$ asymptotically stable.

Corollary 5.1. All fitness neutral type-attributes will achieve a proportion at least equal $\frac{1}{2}$.

Proof. Directly follows from Proposition 5. For the proof of Proposition 5 see Annex 1.

Proposition 5 characterises the fixed points of the equation in the fitness neutral case. These fixed points make intuitive sense: if a fitness neutral type-attribute emerges in

[8] Plotted equation is for g=45 (f=1).

the society then it will achieve at least a proportion of ½. This conclusion corresponds to what one can obtain from mixed strategy Nash equilibrium if the question is specified in a game theoretical way. However, Proposition 5 also implies that it is also possible for this class of type-attributes to reach the status of common consensus (the fixed point 1). This conclusion is also intuitively appealing given that, evident from the proof, it is the initial condition that will dictate which non-zero fixed point (1/2 or 1) is to occur: if a fitness neutral type-attribute emerges in the society with an initial proportion greater than ½ it only makes sense that it grows into common consensus. More interestingly, another possibility for a fitness neutral type-attribute to converge to common consensus is postulated by Proposition 6.

Proposition 6. There is a threshold value of g such that a minority fitness neutral type-attribute can converge to common consensus for any initial condition satisfying $x_0 \in [x_L, x_H]$ where x_0 stands for the initial condition.

Proof. See Annex 1.

The value for the multiplier of social influence payoff (the magnitude of the organized social support) plays a qualitative and quantitative role in how the proportion of the agents carrying a fitness neutral type-attribute will evolve over time. If this multiplier is large enough a minority type-attribute (initial condition below $\frac{1}{2}$) can converge to the fixed point 1. Simply put, even a minority fitness neutral type-attribute can become a common consensus if the multiplier of the organised social support is high enough.

Moreover, Proposition 6 rules out the convergence to common consensus if the initial conditions entail the proximity of a minority type-attribute to $\frac{1}{2}$: it becomes evident from the proof of Proposition 6 that if initial conditions implies at the proximity of x_0 to $\frac{1}{2}$ (x_0 being higher than x_H) the type-attribute will not converge to the fixed point 1 (common consensus). At a first glance, one may expect that only if the initial proportion of the agents carrying the type-attribute under consideration is very low then it may not converge to common consensus. But recall that the dynamics in this equation are determined by two forces: conformity and status-seeking. From there, it is easy to see that in the case where the initial proportion of the individuals carrying the type-attribute under consideration is close to $\frac{1}{2}$ (and below it) these two forces are both almost inoperative (produce weak incentives). As such the proportion of the carrying agents reaches no farther than the smaller of the two positive fixed points i.e., $\frac{1}{2}$.

Proposition 7. The critical interval $[x_L, x_H]$ is a strictly increasing function of the parameter g.

Proof. See Annex 1.

This proposition establishes that the larger the parameter g (hence the importance of organised social support for the type-attribute under consideration) the larger the set of the initial conditions for which a minority type-attribute can converge to common consensus. This proposition also makes intuitive sense.

IV. Conclusion

This paper critically examined the use of the replicator equation in modelling socioeconomic dynamics. As a remedy to the pitfalls enumerated, I proposed a parametric fitness function incorporating the components of social influence, namely conformity and status-seeking, as an amendment to the original version of the equation. This proposition remedies the shortcomings caused by the imperfection of the analogy between evolution in biological systems and social systems. The amended version of the equation (termed behavioural replicator equation) can be used to model the evolution of preferences, behavioural rules and social norms as well as information propagation. I derived a subset of the patterns generated by the proposed equation as a function of parameters, and I discussed how the predictions seem to agree with intuition and empirical observations.

The grounds for application of this equation are large: evolutionary game theory; evolution of preferences; evolution of beliefs and social norms. More precisely, the proposed equation can be used in any context the changes in the proportion of the two types conceived to stand for the heterogeneity in the population can be assumed affected by social influence. Some appropriate contexts for the behavioural replicator equation are where advertising and marketing efforts are being made or where social institutions susceptible to affect the agents' sense of identity are present (e.g. voting and fashion industry).

Moreover, the equation can be used in the modelling of the evolution of a minority behavioural rule to a majority behavioural rule, in other words the passage of status-seeking norms to conformity norms. Also, given that free-trade eliminates border between two usually heterogeneous populations (normally having different types or proportions of types in preferences, behavioural rules or beliefs) this equation can provide predictions about the composition of the population after free-trade.

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ANNEX 1: Proofs

Proposition 1. The behavioural replicator equation can be hill-shaped.

Proof. For the sake of this proof, I need to show that the curve resulting from the equation $x_{t+1} = \frac{x_t}{x_t + (1-x_t)\frac{1}{f+g(x_t-0.5)^2}}$ reaches a local maximum in the interval $[0,1]$. The demonstration follows.

Differentiating the equation yields:

$$\frac{\partial}{\partial x_t}\left[\frac{x_t}{x_t+(1-x_t)\frac{1}{f+g(x_t-\frac{1}{2})^2}}\right]=\frac{-2gx_t{}^3+4gx_t{}^2-2gx_t+f+\frac{g}{4}}{\left(x_t{}^3-gx_t{}^2-x_t+fx_t+\frac{g}{4}+1\right)^2}$$

The denominator is always positive.

Hence, I shall consider the polynomial $\lambda(x_t) = 1 - 2gx_t{}^3 + 4gx_t{}^2 - 2gx_t + f + \frac{g}{4}$ (the numerator):

$$1 - 2gx_t{}^3 + 4gx_t{}^2 - 2gx_t + f + \frac{g}{4} =$$

$$-2gx_t\,(x_t{}^2 - 2gx_t + 1) + f + \frac{g}{4} =$$

$$-2gx_t\,(x_t - 1)^2 + f + \frac{g}{4}$$

The portion $(f + \frac{g}{4})$ is positive for all permissible values of f and g. The minimum value attained by the polynomial $-2gx_t\,(x_t-1)^2$ is $\frac{-8g}{27}$ and it is obtained as follows:

$$\min_{0\leq x_t\leq 1} -2gx_t\,(x_t-1)^2$$

$\frac{\partial[-2gx_t\,(x_t-1)^2]}{\partial x_t}= -2g(3{x_t}^2-4x_t+1) \xrightarrow{yields}$ for $g \neq 0$ $x_t=\frac{1}{3} \xrightarrow{yields} \gamma\left(x_t=\frac{1}{3}\right)=\frac{-8g}{27}$

From the above I get:

$\frac{\partial}{\partial x_t}\left[\frac{x_t}{x_t+(1-x_t)\frac{1}{f+g(x_t-\frac{1}{2})^2}}\right]>\mathbf{0}$ if and only if $f+\frac{g}{4}+\frac{-8g}{27}>0$ or if and only if $\frac{f}{g}>\frac{5}{108}$

The inequality $\frac{f}{g}>\frac{5}{108}$ does not hold for all permissible values of the parameters f and g. Therefore, the first derivative can be negative implying the possibility of decreasing portions for the equation following an increasing portion i.e., the equation can be hill-shaped **QED**■

Proposition 2. For all values of g and any initial condition the proportion of the agents carrying the type-attribute under consideration will not decrease unless the parameter f is a constant smaller than unity.

Proof. I need to show that x_{t+1}- x_t <0 implies$f<1$:

x_{t+1}- x_t <0 $\Leftrightarrow$

$\frac{x_t}{x_t+(1-x_t)\frac{1}{f+g(x_t-\frac{1}{2})^2}}$- x_t <0 $\Leftrightarrow$

$x_t\,(1-x_t)\left[\frac{g{x_t}^2-gx_t+f+\frac{g}{4}-1}{1+g{x_t}^3-g{x_t}^2+fx_t-x_t+\frac{gx_t}{4}}\right]<0$

To determine the parameter value requirements for the last inequality to hold I need to determine the sign of the polynomials $g{x_t}^2-gx_t+fx_t+\frac{g}{4}-1$ and $1+g{x_t}^3-g{x_t}^2+$

$fx_t - x_t + \frac{gx_t}{4}$ since the expression x_t $(1 - x_t)$ is always positive. These signs are determined below as a function of parameters.

(i) Sign of $1 + gx_t{}^3 - gx_t{}^2 + fx_t - x_t + \frac{gx_t}{4}$:

$1 + gx_t{}^3 - gx_t{}^2 + fx_t - x_t + \frac{gx_t}{4}$=

$$[1 + fx_t] + x_t \left[gx_t{}^2 - gx_t + \frac{g}{4} - 1\right]$$

$[1 + fx_t]$ is an increasing function of x_t and always strictly positive.

For the polynomial $\lambda(x_t) = [gx_t{}^2 - gx_t + \frac{g}{4} - 1]$ I have:

$$\frac{\partial[gx_t{}^2 - gx_t + \frac{g}{4} - 1]}{\partial x_t} = 2gx_t - g$$

$$\frac{\partial^2[gx_t{}^2 - gx_t + \frac{g}{4} - 1]}{\partial x_t^2} = 2g$$

which implies $\lambda(x_t)$ reaches its minimum at x_t=$\frac{1}{2}$. This point is the minimum attained by x_t $[gx_t{}^2 - gx_t + \frac{g}{4} - 1]$ as well. Its value is $\frac{1}{2}[g(\frac{1}{2})^2 - g\frac{1}{2} + \frac{g}{4} - 1]$ =$\frac{-1}{2}$

It follows that $gx_t{}^3 - gx_t{}^2 - x_t + \frac{gx_t}{4} + 1 + fx_t = \frac{-1}{2} + 1 + fx_t = \frac{1}{2} + fx_t$ is strictly positive for all permissible values of f.

(ii) Sign of $gx_t{}^2 - gx_t + f + \frac{g}{4} - 1$:

$gx_t{}^2 - gx_t + f + \frac{g}{4} - 1$= $\left[gx_t{}^2 - gx_t + \frac{g}{4} - 1\right] + f$

I have shown the minimum of $g{x_t}^2 - gx_t + \frac{g}{4} - 1$ is reached at x_t=$\frac{1}{2}$. This minimum is

$[g\left((\frac{1}{2})^2 - g\frac{1}{2} + \frac{g}{4} - 1\right] = -1$

Therefore it is only for $f < 1$ that the polynomial $g{x_t}^2 - gx_t + f + \frac{g}{4} - 1$ becomes strictly negative. It follows from (i) and (ii) that x_{t+1}- x_t <0 holds only for $f < 1$ **QED■**

Proposition 3. The curve resulting from the equation of a fitness neutral type-attribute can be hill-shaped.

Proof. I need to show that the curve resulting from behavioural replicator equation for a fitness neutral type-attribute reaches a local maximum in the interval $[0,1]$. The equation for a fitness neutral type-attribute becomes $x_{t+1} = \frac{x_t}{x_t + (1-x_t)\frac{1}{1+g(x_t - \frac{1}{2})^2}}$ and the proof follows. Differentiating the equation results in:

$$\frac{\partial}{\partial x_t}\left[\frac{x_t}{x_t + (1-x_t)\frac{1}{1+g(x_t-\frac{1}{2})^2}}\right] = \frac{1-2g{x_t}^3 + 4g{x_t}^2 - 2gx_t + \frac{g}{4}}{\left({x_t}^3 - g{x_t}^2 + \frac{g}{4} + 1\right)^2}$$

The sign of the derivative uniquely depends on the numerator, let us call it $\lambda(x_t)$:

$$\lambda(x_t) = 1 - 2g{x_t}^3 + 4g{x_t}^2 - 2gx_t + \frac{g}{4} = \left[-2g{x_t}^3 + 4g{x_t}^2 - 2gx_t\right] + \left[1 + \frac{g}{4}\right] =$$

$$-2gx_t\ [{x_t}^2 - 2x_t + 1] + \left[1 + \frac{g}{4}\right] =$$

$$-2gx_t\ (x_t - 1)^2 + \left[1 + \frac{g}{4}\right]$$

Therefore the sign of $\lambda(x_t)$ depends on g and after doing the algebra it results in:

(i) For $g \leq \frac{108}{5}$ it is strictly positive;

(ii) For $g > \frac{108}{5}$ it is strictly positive over the interval $\left(0, \frac{19}{100}\right) \cup \left(\frac{1}{2}, 1\right)$ and strictly negative otherwise;

It follows from (i) and (ii) and given that $\frac{19}{100} < \frac{1}{2}$ that the curve reaches a local maximum in the interval $\left(0, \frac{1}{2}\right)$ which is a subset of $[0,1]$ **QED■**

Proposition 4. For all values of g and any initial condition, the proportion of the agents carrying a fitness neutral type-attribute will never decrease.

Proof. For this proof, I need to show that $x_{t+1} - x_t \geq 0$ for all $x_t \in [0, 1]$:

$$x_{t+1} - x_t = \frac{x_t}{x_t + (1 - x_t)\frac{1}{1 + g(x_t - \frac{1}{2})^2}} - x_t$$

$$= g x_t\ (1 - x_t) \frac{{x_t}^2 - x_t + \frac{1}{4}}{1 + g{x_t}^3 - g{x_t}^2 + \frac{g x_t}{4}} = g x_t\ (1 - x_t) \frac{\left(x_t - \frac{1}{2}\right)^2}{1 + g{x_t}^3 - g{x_t}^2 + \frac{g x_t}{4}}$$

Given that $g x_t\ (x_t - 1)\left(x_t - \frac{1}{2}\right)^2$ is positive for all x_t I need to determine the sign of the polynomial $1 + g{x_t}^3 - g{x_t}^2 + \frac{g x_t}{4}$.

Sign of $1 + g{x_t}^3 - g{x_t}^2 + \frac{g x_t}{4}$ can be determined through the simplifications that follow:

$$1 + g{x_t}^3 - g{x_t}^2 + \frac{g x_t}{4} = 1 + \left[g{x_t}^3 - g{x_t}^2 + \frac{g x_t}{4}\right] = 1 + g x_t \left[{x_t}^2 - x_t + \frac{1}{4}\right]$$

The term $\left[{x_t}^2 - x_t + \frac{1}{4}\right]$ reaches its minimum at x_t=$\frac{1}{2}$ and the minimum value attained by the expression is: 1+$\frac{g}{2}\left[\frac{1}{4} - \frac{1}{2} + \frac{1}{4}\right]$=1.

Hence $1 + g{x_t}^3 - g{x_t}^2 + \frac{gx_t}{4}$ is guaranteed to be positive for all x_t and with this, I have also shown that x_{t+1}- x_t is always positive **QED**■

Proposition 5. For a fitness neutral type-attribute there are three fixed points {0, 1/2,1}; while 0 and 1 are stable fixed points $\frac{1}{2}$ asymptotically stable.

Proof. Recall that the multiplier of social influence payoff, g, is assumed to be a real number greater than unity. A fixed point satisfies $x_{t+1} = x_t = \hat{x}$; solving $\frac{\hat{x}}{\hat{x}+(1-\hat{x})\frac{1}{1+g(\hat{x}-\frac{1}{2})^2}}$= $\hat{x}$ results in $\hat{x} \in \left\{0, \frac{1}{2}, 1\right\}$ for $g \neq 0$. And I have:

$$\frac{\partial}{\partial x_t}\left[\frac{x_t}{x_t + (1-x_t)\frac{1}{1+g(x_t - \frac{1}{2})^2}}\right]_{x_t = \frac{1}{2}} = \left[\frac{1-2g{x_t}^3 + 4g{x_t}^2 - 2gx_t + \frac{g}{4}}{\left({x_t}^3 - g{x_t}^2 + \frac{g}{4} + 1\right)^2}\right]_{x_t = \frac{1}{2}} = 1$$

The slope being equal unity means the fixed point $\frac{1}{2}$ is a tangency to the 45° line ($x_{t+1} = x_t$) implying asymptotic stability **QED**■

Proposition 6. There is a threshold value of g such that a minority fitness neutral type-attribute can converge to common consensus for any initial condition satisfying $x_0 \in [x_L, x_H]$ where x_0 stands for the initial condition.

Proof. Notice (i) I have from Proposition 3 that there is a local maximum in the interval $(0, \frac{1}{2})$; (ii) As shown in below, the straight line x_{t+1}=$\frac{1}{2}$ may intersect with the curve $\Upsilon(x_t) = x_{t+1} = \frac{x_t}{x_t+(1-x_t)\frac{1}{1+g(x_t-\frac{1}{2})^2}}$ up to three times in the interval $\left[0, \frac{1}{2}\right]$:

$$\frac{x_t}{x_t+(1-x_t)\frac{1}{1+g(x_t-\frac{1}{2})^2}} = \frac{1}{2} \Rightarrow x_t \in \left\{\frac{1}{4g}\left(g - \sqrt{g(g-32)}\right), \frac{1}{4g}\left(g + \sqrt{g(g-32)}\right), \frac{1}{2}\right\}$$

Putting (i) and (ii) together I deduce that first, a local maximum is reached in the interval $(0, \frac{1}{2})$; second, if the value of the local maximum in the interval $(0, \frac{1}{2})$ is greater than $\frac{1}{2}$ then there is a non-empty interval such that it possible for x_t to jumps over the fixed point $\frac{1}{2}$ and to converge to the fixed point 1 or the status of common consensus (see Figure 6).

The parameter value requirement for the above is determined below.

Solving $\frac{1}{4g}\left(g - \sqrt{g(g-32)}\right) = \frac{1}{4g}\left(g + \sqrt{g(g-32)}\right) \xrightarrow{yields} g = 32$

Hence, for the parameter value $g = 32$ the local maximum of the behavioural replicator equation, $\frac{x}{x+(1-x)\frac{1}{1+g(x-\frac{1}{2})^2}}$, is tangent to the straight line $x_{t+1} = \frac{1}{2}$ which means:

(i) If $g < 32$ then the entirety of the curve up the point $x_t = \frac{1}{2}$ is below the straight line $x_{t+1} = \frac{1}{2}$ therefore for the initial conditions $x_0 \in (0, \frac{1}{2})$ the fixed is $\frac{1}{2}$. The type-attribute under consideration will only converge to common consensus only when $x_0 \in (\frac{1}{2}, 1]$.

(ii) If $g = 32$ then the local maximum of the curve is tangent to the straight line $x_{t+1} = \frac{1}{2}$; hence the fixed point will be again $\frac{1}{2}$ and only the speed of convergence will differ from (be faster than) the case described in (i). The type-attribute under consideration will only converge to common consensus when $x_0 \in (\frac{1}{2}, 1]$.

(iii) If $g > 32$ then three distinct intersections with the straight line $x_{t+1} = \frac{1}{2}$ exist; hence for initial conditions $x_0 \in \left[\frac{1}{4g}\left(g - \sqrt{g(g-32)}\right), \frac{1}{4g}\left(g + \sqrt{g(g-32)}\right)\right] \subset [0, \frac{1}{2})$ a minority type-attribute will not get trapped at the fixed point $\frac{1}{2}$ but converges to common consensus. It also becomes evident that the points defining the critical interval for the initial point x_0 are $x_L = \frac{1}{4g}\left(g - \sqrt{g(g-32)}\right)$ and $x_H = \frac{1}{4g}\left(g + \sqrt{g(g-32)}\right)$ and these points are making a non-empty interval $[x_L, x_H]$ since for this range of g obviously $x_L \neq x_H$ **QED■**

Proposition 7. The critical interval $[x_L, x_H]$ is a strictly increasing function of the parameter g.

Proof. Let m stand for the length of the critical interval $[x_L, x_H]$. Then I have:

$$m = x_H - x_L = \left[\frac{1}{4g}\left(g + \sqrt{g(g-32)}\right)\right] - \left[\frac{1}{4g}\left(g - \sqrt{g(g-32)}\right)\right] = \frac{\sqrt{g(g-32)}}{2g}$$

Recall that according to Proposition 6 x_L and x_H are defined only for $g > 32$. A strictly positive derivative for $g > 32$ establishes the result. Differentiating the expression for m with respect to g I get:

$$\frac{d\left[\frac{1}{2g}\left(\sqrt{g(g-32)}\right)\right]}{dg} = \frac{8}{g\sqrt{g(g-32)}} > 0 \text{ for all } g > 32$$ **QED■**

ANNEX 2: Figures

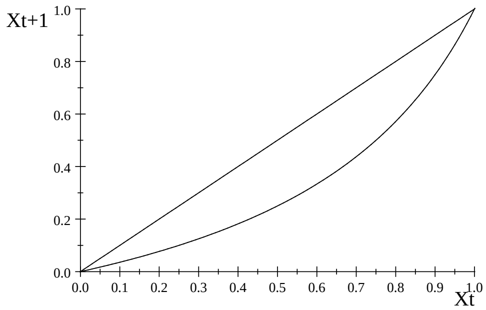

Figure 1.

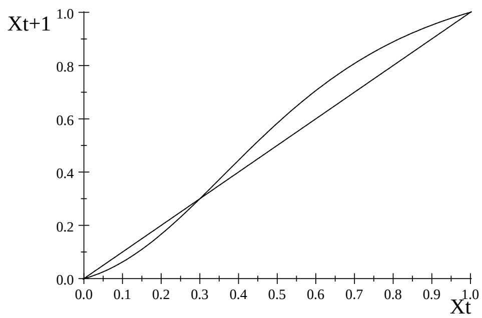

Figure 2.

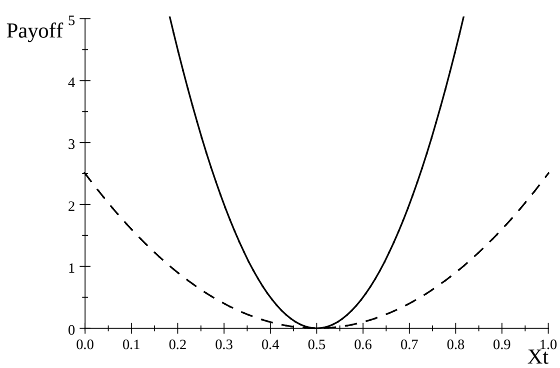

Figure 3.

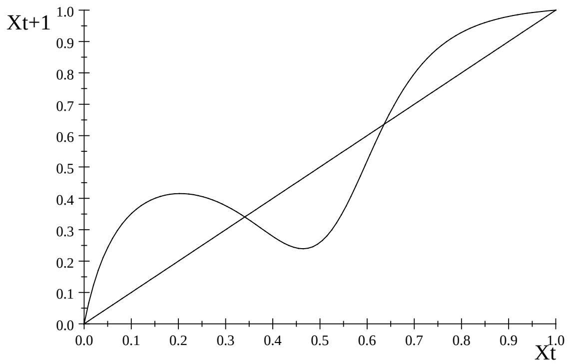

Figure 4.

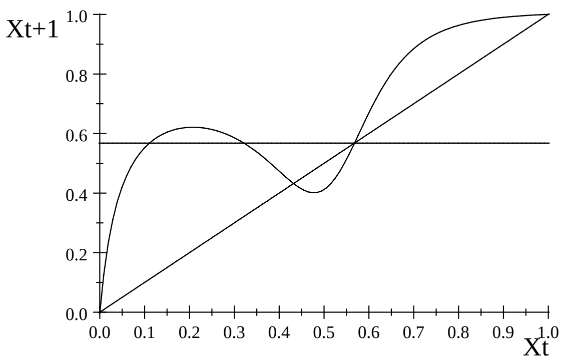

Figure 5.

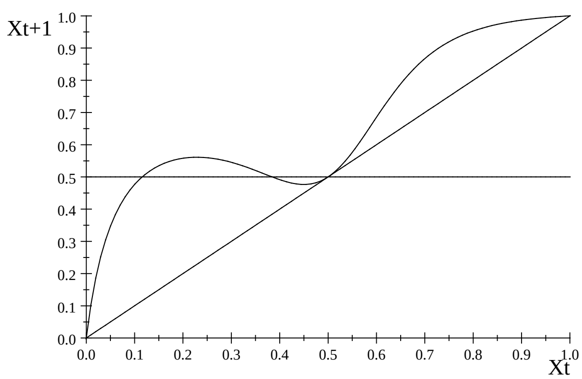

Figure 6.

Conclusion

This thesis explored the grounds of application of economic theory and methodology in the understanding of some social institutions with economic consequences (namely visual artists' compensation schemes, religiosity and social influence). Economic methodology has been applied to both qualitative and quantitative examination of these institutions.

In my first essay (with Professor Jim Engle-Warnick), I showed using experimental methodology that the institution of resale royalty (*droit de suite*) might adversely affect the welfare of visual artists (painters and sculptors). This essay, conceived in the perspective of economic analysis of legal institutions, contributes to the efforts made in the adoption of economically efficient legislations.

My second essay filled a gap in the knowledge of stylised facts about the relationship between religiosity and wage as well as the factors behind the wage gap among religious groups in Canada. This empirical research, using Ethnic Diversity Survey conducted in 2004 by Statistic Canada, has not only contributed new facts about the relationship between religiosity and earnings but also it has updated, after 25 years, the strand of research on the earning gaps among religious groups in Canada: I found for the first time that the relationship between religiosity and wage is negative and that statistically significant wage gaps exist among religious groups.

Finally, my last essay proposed an equation that can provide qualitative and quantitative predictions about the evolution of types (of preferences, behavioural rules and beliefs) in a heterogeneous population. The results proved to be constructive in analytically integrating psychological and sociological insights into the field of economics. The conception proposed in this paper can provide analytical frameworks for the study of a number of socioeconomic patterns such as the persistence of other-regarding and altruistic behaviours in human societies as well as the passage of the norms of status-seeking to the norms of conformity, which could previously be only inadequately examined using economic methodology.