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The theology of large numbers: a conjecture

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Abstract

The aim of this paper is to discuss the implicit theology underlying a central assumption of the fourth part of the *Ars Conjectandi*: the affirmation of divine omniscience and omnipotence. From the standpoint of medieval theology, Bernoulli's assumption involved two different problems: whether we were really free to choose and what moral significance a probabilistic election may have. We will discuss its intellectual roots, exploring the correspondence with Leibniz in the light of the controversy between Dominicans and Jesuits as to God's concurrence in our actions. By way of conclusion, we will briefly discuss the moral significance that might be granted to the *Ars Conjectandi* from a Calvinist perspective, and in what precise sense probability was rendered a secular tool for decision making

Résumé

Le but de cet article est de discuter la théologie qui sous-tend une hypothèse centrale de la quatrième partie de l' *Ars Conjectandi* : l'affirmation de l'omniscience et de l'omnipotence divine. Du point de vue de la théologie médiévale cette hypothèse impliquait deux problèmes différents : étions-nous réellement libre de nos choix et quelle signification morale pouvait avoir un choix probabiliste. Nous discuterons ses racines intellectuelles, en explorant la correspondance avec Leibniz à la lumière de la controverse entre les Dominicains et les Jésuites sur la façon pour Dieu d'intervenir dans nos actes. En guise de conclusion, nous discuterons brièvement la signification morale qui pourrait être attachée à l' *Ars Conjectandi* dans une perspective Calviniste, et en quel sens précis la probabilité devint un outil séculier de la prise de décision.

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I. A CONJECTURE ABOUT THE *ARS CONJECTANDI*

The aim of this paper is to discuss the implicit theology underlying a central assumption of the fourth part of the *Ars Conjectandi* (AC): the affirmation of divine omniscience and omnipotence. We know well that Bernoulli was a qualified theologian who studied to become a pastor in Basel. However, his scarce writings on these matters still remain unpublished. We will thus present a conjecture that these manuscripts may eventually confirm. From the standpoint of medieval theology, Bernoulli's assumption involved two different problems: whether we were really free to choose and what moral significance could a probabilistic election have. Both questions had been discussed at length throughout the previous two centuries and it seems quite unlikely that Bernoulli could have ignored them, even if in the AC he skipped the discussion of both. Our conjecture is rather that there was an implicit commitment to a catholic theological tradition, later extended in protestant countries, which affirmed that the divine foreknowledge of an event necessitated either its taking or not taking place –since God knows simultaneously whether he wants it to happen.

We will present in §2 this position, usually associated to Bañez and the Dominicans tradition, together with the Jesuit alternative, in order to see how the former supports the mathematical implications that Bernoulli wanted to draw from his assumption. In §3 we will show how such implications were contested by Leibniz on the basis of the latter, i.e., on Molinist grounds, in a way that was immediately relevant for the ecclesiastical concerns of Bernoulli's circle in Basel. By way of conclusion, we will briefly discuss the moral significance that from a Calvinist perspective might be

granted to the AC, raising the question of how it could have been transformed into a secular tool for decision making after Bernoulli.

2. A THEOLOGICAL ASSUMPTION IN THE AC

In the first preliminary chapter of the fourth part of the *Ars conjectandi*, a number of concepts (such as *probabilitas*, *possibile*, *contingens*, etc.) are defined in order to clarify their further application. The first one of these (*certitudo*) is explained with a brief theological digression, that we will examine in detail.

In themselves and objectively, all things under the sun, which are, were, or will be, always have the highest certainty. [...] Nor should there be any doubt about future things, which in like manner, even if not by the necessity of some inevitable fate, nevertheless by divine foreknowledge and predetermination, cannot not be in the future. Unless, indeed, whatever will be will occur with certainty, it is not apparent how the praise of the highest Creator's omniscience and omnipotence can prevail. Others may dispute how this certainty of future occurrences may coexist with the contingency and freedom of secondary causes; we do not wish to deal with matters extraneous to our goal. [Bernoulli, 1713, 210-11; Sylla, 2006, 315]³

Bernoulli kept his promise: there is indeed no discussion of this (or any other) theological issue in the AC. However, according to some interpreters, this had more to do with his goal than it may initially appear. Lorraine Daston [1992] has argued that it allowed Bernoulli to reconcile, anachronistically speaking, theoretical probabilities and

³ The original text reads as follows: «Omnia, quae sub Sole sunt vel fiunt, praeterita, praesentia sive futura, in se & objective summan semper certitudinem habent. [...] Nec de futuris ambigendum, quae pariter etsi non fati alicujus inevitabili necessitate, tamen ratione tum praesciantiae tum praedeterminationis divinae non possunt non fore; nisi enim certo eveniant quaecunq; futura sunt, non apparet, quo pacto summo Creatori omniscientiae & omnipotentiae laus illibata constare queat. Quomodo autem haec futuritionis certitudo cum contingentia aut libertate causarum secundarum consistere possit, de hoc disputent alii; nos a scopo nostro aliena nolumus tangere»

empirical frequencies. Whereas for previous authors, such as Cardano, variability in the world complicated the approximation of the former through the latter, Bernoulli's theological determinism granted that in the long run the observed ratios would come as close to the true ones as we want them to. The God of the AC could not have created anything "inherently uncertain and indeterminate". In other words, the intensity of our beliefs could be mathematically adjusted independently of their content, granting a rational foundation to any decision we should make. This was precisely the topic of the AC fourth part: the application of probabilities to civic, moral and economic matters. The doctrine of predestination prevalent in Bernoulli's protestant background, suggests Daston [1992, 46], endowed him with a crucial argument to expand the aims and scope of the doctrine of chances — see also [Sylla, 2006, 19].

Edith Sylla [1997] has shown how this theological assumption is relevant to understand what the law of large numbers proved. The binomial expansions underlying the proof express the number of ways in which various possible outcomes of a series of observations can occur. I.e., the terms of these expansions represent total ratios of events *in the world*: Bernoulli's algebraic approach proceeds as if all cases (*casus*) were simultaneously displayed, without priority or posteriority.⁴ According to him, such a distinction is only introduced by our own perspective, but does not correspond to the divine vision of the whole set of events and its causal order. Through the binomial theorem we can at least discern its mathematical arrangement. And even if our current empirical frequencies do not represent but the complex interaction of such causes, the approximation that we can obtain through these is good enough for all practical purposes. Its precision can be theoretically bounded through the analysis of its binomial

⁴ For an analysis of the proof, cf. [Meusnier, 1990]

expansion. For Bernoulli, the law of large numbers thus guaranteed that the discovery of true ratios through empirical frequencies was feasible.⁵

Divine foreknowledge and predetermination was thus crucial to project, so to speak, mathematical probabilities onto our world and confer its practical significance to the AC. Yet, the theological implications of such a radical stance were not unsubstantial: to affirm the unconstrained omniscience and omnipotence of God amounted to eliminate any autonomy we could claim for our foreordained decisions. From the modern standpoint, this may seem quite a paradoxical starting point for an *Ars* intended to provide wise advice to choose the «superior, more advantageous, safer or better considered». From a theological perspective, this was not such a morally puzzling choice: the primacy of law –revealed, natural or positive– over conscience was commonly admitted, as a direct or indirect expression of the divine will.⁶ However, it was equally acknowledged that there were many cases in which genuine uncertainty existed as to the most adequate decision to make. In such cases, the assumption was that we should discern the «more advantageous, safer or better considered» alternative. Probability would therefore help us to choose in accordance with the causal order arranged by God, and in conformity also with His will of making us use the AC to reach such a decision.

Two dilemmas immediately appeared: whether there was a single superior option or many and whether our choice of any of them was preordained. The AC provided a clear strategy to address the first dilemma, skipping the discussion of the second. Yet, Bernoulli did perceive that the autonomy of our decisions (even in a

⁵ Obviously, this solution to the *central problem of statistical inference* has been contested: cf., e.g., [Hacking, 1971], [Rivadulla, 1997].

⁶ For a discussion regarding probable judgments, cf. [Demian, 1936, cc. 417-32]. The theological implications of this position in the theological context of Calvinism are discussed in [García Alonso, 2006a]

narrow theological sense) constituted quite a thorny issue, which may lead some to question the AC.

«Some people» had indeed been arguing about «about how this certainty of future existence can agree with dependency upon or independency of secondary causes». Since at least the 1660s the Jesuits had been fighting a fierce theological battle about grace and human freedom, which led Pope Clement VIII to establish a commission (the *Congregatio De Auxiliis*) to reach a doctrinal consensus between the Society and its theological adversaries. After a decade of research and debate, Pope Paul V issued a decree in 1607 allowing both the Jesuits and their opponents to defend their views, which was an implicit admission that their dispute was theologically thorny enough to challenge his doctrinal authority.⁷

The issue at stake was the conciliation of human freedom and divine omniscience and omnipotence. It was agreed by all catholic theologians that God acted as a general cause of the creation and conservation of every contingent being. To the secondary causal action of the latter, God contributed as an immediate efficient cause. God's simultaneous concurrence is said to be "efficacious" with respect to it when the intended effect is produced in accordance to His design, and "merely sufficient" otherwise. When an agent acts wrongly, she holds full causal responsibility for the evil done: God concurs sufficiently for it to happen, but not efficaciously since the act goes against His intentions. Could He not anticipate when such disobedience would take place? According to a theological party led by Domingo Bañez⁸, this was impossible.

⁷ The bibliography on this topic is really extensive: a recent collection of texts showing the development of the problem is [Bardout & Boulnois, 2002]. A standard account is [Stegmüller 1935]

⁸ Domingo Bañez (1528-1604) entered the Dominican Order in 1546, after studying theology in Salamanca, under Melchor Cano (1548-51), Diego de Chaves (1551), and Pedro Sotomayor (1550-51). He became an orthodox Thomist theologian, holding a series of teaching and administrative posts in Avila, Alcalá, Valladolid and Toro. In 1577 he returned to the University of Salamanca where he taught theology until he retired in 1600. He was also director and confessor of St. Teresa His intellectual

God knows how He will causally concur to each of our particular decisions and therefore. He knows whether we will fail to elicit the morally good act that He intends. His knowledge of his own Will sustains His “knowledge of vision” of the created world.⁹

The Jesuits, after Luis de Molina, argued that God’s concurrence was intrinsically neutral and it is externally rendered efficacious or merely sufficient by our consent or disobedience to His intentions. But that implied that His knowledge of the creation was somehow incomplete: He could anticipate infallibly all possible contingent truths, remaining neutral as to the actual causation of our decisions. He had a “middle knowledge” (*scientia media*) of them, seeing *futuribilia* in their essence without having to establish predetermined decrees. Only after our world is actually created, he gains free knowledge of all future contingents.¹⁰

For Bernoulli, it was this «certainty of future existence» which rendered problematic the contingency of our decisions as second causes (*contingentia aut libertate causarum secundarum*) of our actual actions. However, he apparently took sides with the Dominican tradition and assumed that the divine foreknowledge of our decisions was unconstrained. As stated in the AC, contingent events do not always exclude necessity –even regarding secondary causes (*causas secundas*)–, which was another way of saying that, *in relation to us*, we may safely presume that there is underlying cause of every event [Bernoulli, 1713 1975, 212-13].

Now, as Edith Sylla made us notice, «the mathematics takes a “God’s eye” point of view, in which every possibility is present on an equal footing» [Sylla, 1997, 93]. In

influence on the Thomist scholastic was enduring, beyond his contribution to the *De auxiliis controversy*, though we will not discuss it here.

⁹ Bañez’s views are summarised in his *Apologia fratrum praedicatorum adversus quasdam assertiones cuiusdam doctoris Ludovici Molinae nuncupati* (1592)

¹⁰ Molina’s masterpiece was the *Liberi arbitrii cum gratiae donis, divina praescientia, providentia, praedestinatione et reprobatione concordia* (1588).

other words, our algebraic representation of the *possibilia* somehow simulates divine foreknowledge. And since it necessitates the actual events, without Molinist provisos, we can approximate the true ratios of each possible casus through empirical frequencies. Had Bernoulli conceived of divine foreknowledge as Molina, he wouldn't have been able to construe such an algebra of possible events. Or at least this is how a very qualified contemporary perceived it, as we are going to see in the next section.

3. A MOLINIST OBJECTION AGAINST THE AC

Between 1703 and 1705, Leibniz and Bernoulli exchanged at least twenty letters many of which dealt with the theory of probability¹¹. Leibniz, who had been alerted of the existence of the AC by Johann Bernoulli in 1697, immediately perceived its relevance for his own queries concerning the formalization of political and juridical reasoning. Leibniz never came to see the manuscript, but Jakob informed him about several relevant points, among which his crucial claim on the approximation of a priori ratios through empirical frequencies. Leibniz's reaction deserves a careful analysis, since it targets the theological assumption that Bernoulli judged unrelated to the goal of the AC.

When we estimate probabilities empirically by results in succession, you ask whether in that way finally a perfect estimate could be obtained, and you write that this has been found by you. The difficulty in it seems to me that contingent things or things that depend on infinitely many circumstances cannot be determined by finitely many results, for nature has its habits, following from the

¹¹ A thorough analysis of this exchange is provided by [Sylla, 1998]

return of causes, but only for the most part. [Weil *et al.*, 1993, 123; Sylla, 2006, 39]¹²

Leibniz ignored Bernoulli's proof, but nevertheless he was questioning its main conceptual presupposition, that contingent events could be mathematically tractable the way Bernoulli claimed. Contingent events were not foreknown to God algebraically:

In the case of contingent truths, even though the predicate is in the subject, this can never be demonstrated of it, nor can the proposition ever be reduced to an equation of identity, God alone seeing –not the end of the analysis, since it has no end– but the connexion of terms or the inclusion of the predicate in the subject, for He sees whatever is in the series. [Leibniz (1689) 1973, 109]¹³

Let us briefly put this citation in context. For Leibniz, necessary truths, such as mathematical propositions, expressed some sort of identity between their subject and predicate. To deny them would thus imply a contradiction. In turn, the connection between subject and predicate in contingent truths cannot be reduced to any identity, since the latter contains an infinity of notes that cannot be exhausted in a finite number of steps. The notion of each individual substance contains indeed all possible (infinitely many) circumstances in which it can exist.

To affirm that God cannot know contingent truths mathematically implies thus that the infinity of notes constituting their predicate cannot be reduced to a tractable algebraic form, as Bernoulli assumed. Yet, that God can know such truths *visually* provides a key to the side Leibniz was taking as to the theological controversy mentioned above. Attempting to reconcile our free will with divine omniscience and

¹² Leibniz to Bernoulli, November 26th 1703. Cf. [Ferriani, 1982, 175-82] for a different analysis, which emphasises the parallelism between our two correspondents.

¹³ *De libertate, contingentia et serie causarum, providentia* (VE, pp. 1767-1772). We have much benefited from the annotated compilation of Leibnizian texts on chance, freedom and predestination edited by Concha Roldán: [Roldán 1990].

omnipotence, Leibniz took advantage of the following intuition: God foreknows every future event, but these remain contingent as long as the contrary (that they do not happen) is not logically impossible. Contingent events are thus not unconditionally necessary: God foresees every possible world in its contingency and decrees later which one comes to exist as such. His Will does not make necessary any event taking place in it. That is, divine omniscience can prevail without altering the modal status of His creation: whereas necessary truths relate only to God's intelligence, the notion of each contingent being is dependent of the divine Decree as to the time and place when it should happen. This is precisely the standpoint of Molina. God chooses what He wills best among these contingent alternatives¹⁴.

Let us focus now on the implications of this Leibnizian stance regarding probability. Leibniz defended that when facing uncertain alternatives, we should opt for the morally safest and that such decision could be improved by mathematical means¹⁵. Yet, unlike Bernoulli, Leibniz contended that probabilities could not be calculated, but rather *estimated*¹⁶. Probabilities are assigned either on the basis of various conventions or of simple ignorance (which might justify an assumption of equiprobability). But we cannot aspire to build a demonstrative order in probability, because we were dealing with essentially contingent events, and their infinity of notes is mathematically intractable. The use of algebra to simulate the divine foreknowledge of such events, as Bernoulli suggested, was for Leibniz unfeasible: there was no predetermined finite number of *casus* corresponding to the actual world, but an actual infinity of them.

¹⁴ We follow here [Kaphagawani, 1999]. Yet we should note that Leibniz was closer to Bañez regarding the divine concurrence in our actual decisions, though we will skip now the analysis. Cf., e.g., *Conversatio cum domino episcopo Stenonio de libertate* (1677; VE, pp. 298-305) in [Roldán, 1990, 177-90]. See also in this respect [Greenberg 2005].

¹⁵ Leibniz took sides with Tirso González, SJ, to defend *probabiliorism* –cf. [Deman, 1936, cc. 539-547]: e.g., *NE IV*, 2, §14. For a brief introduction focused on the origins of mathematical probability, cf. [Franklin, 2001, 64-101].

¹⁶ We follow here [Parmentier, 1995, 7-43] and [Rohrbasser & Veron, 2001, 67-88].

Bernoulli's response questioned that *a posteriori* that infinity of causes was really intractable («It is known that even in the infinite there are degrees» [Weil *et al.*, 1993, 129]). *A priori* he relied on an urn model of possibilities grounded on divine omniscience that was causally efficient to produce actual events. His approach was mathematically convenient and concordant with a well established theological stance. Bernoulli could have thus dismissed Leibniz's objections without second thoughts. Except, perhaps, for their ecclesiastical implications.

In the same letter in which those objections were presented, Leibniz also answered a question that Bernoulli had sent him on behalf of certain Swiss protestant theologians¹⁷. They wanted to know his opinion as to the unification of the different protestant creeds. Leibniz was then acting as an advisor in a council, the *Collegium Irenicum*, promoted by the Prussian king to achieve the religious unification of Lutherans and Calvinists within his territories [Schrecker, 1934, 47-50]. His response probably reflected the obstacles that he was most used to find in such enterprise:

Concerning the business of predestination, it seems to me that hardly any difficulty remains, provided that [considerations that] may seem to create prejudice concerning the divine attributes of justice, wisdom, and sanctity are avoided, and all acknowledge that God acts justly, not only because He is all powerful, but also because he is most wise and good, such that it is established that nothing could have been done better than He did it, even if to us who are not admitted to the whole harmony of things it may not appear so. Once this is established, the questions about absolute or conditional decrees and universal or

¹⁷ Bernoulli to Leibniz, October 3rd, 1703: «Nonnulli non infimae notae Theologi Reformatae nostrae Helvetiae in mandatis mihi dederunt, ut quaerent ex Te, cujus iudicium consiliumque faciunt maximi, quid sentias de pace inter Protestantes utriusque communionis Lutheranos et Reformatos (*Syncretismum* vocant) attentanda [...]» [Weil *et al.*, 1993, 117-18]

particular grace seem partly philosophical and partly verbal. [Weil *et al.*, 1993, 125; trans. E. Sylla]¹⁸

The unity of the Swiss protestant churches had been an issue for already several decades in Basel. The theology professor and Head (*Antistes*) of the Church of Basel Lukas Gernler (1625-1676) had cooperated with other Swiss theologians to achieve a «Formula Consensus Ecclesiarum Helveticarum Reformatorum» in 1675, of which various canons dealt indeed with predestination. A year later, the young Jakob composed an encomiastic funerary ode to Gernler [Weil *et al.*, 1993, p. 205]. Another scholar even more in favour of doctrinal unity, Peter Werenfels, served as Antistes between 1675 and 1703, and dispensed with the Formula in 1686 at the suggestion of the elector F.W. von Brandenburg to facilitate union among Protestants [Staehelin, 1957, 264]. Among Werenfels' students at the University of Basel was again Bernoulli, who had him as advisor of his dissertation *De primi et secundi Adami collatione* precisely in 1676 [Weil *et al.*, 1993, 39].

One of the most controversial issues in the Formula had been to decide whether the original sin could be mediately or immediately imputed to our race. I.e., either Adam's individual transgression corrupted the nature of his descendants by physical generation or Adam failed to stand a moral probation on behalf of all his descendants so that they became responsible derivatively. According to the former, we would be condemned prior to any native depravity or personal transgression, since our race would have taken active part in the original sin. Whereas for the latter, we would only be mediately responsible. The Formula opted for immediate imputation, which seems quite

¹⁸ «Circa praedestinationis negotium vix mihi videtur superesse difficultas: modo evitentur quae attributis divinis justitiae, sapientiae, sanctitati praejudicium creare videri possent agnoscatque omnia Deum juste agere, non modo quia summe est potens, sed et quia summe sapiens bonusque, ita ut statuendum sit nihil fieri posse melius quam quod facit, etsi nobis in totam rerum harmoniam non admissis id apparere non possit. Hoc constituto quaestiones de absoluto vel conditionali decreto, gratiaque universali aut particulari partim philosophicae, partim verbales videntur.» We owe to E. Sylla a correction of our previous misguided version.

coherent with the defense of predestination “before the creation of the world” and the concordant denial (Canon VI) of any sort of conditional salvation *ex post* for those redeemed in Christ, the *second Adam*. In his *Meditationes XVII-XVIII*, written around 1677-1680, there is evidence that Bernoulli was close to this position [Sylla, 2006, 353]

Only an examination of the unpublished theological manuscripts of Bernoulli will reveal whether he challenged such theses the same year they were consensuated, or whether he evolved to a milder form of orthodoxy, as the Werenfels defended¹⁹. It seems quite likely to us that by 1703 Bernoulli still adhered to a more or less traditional view on predestination, which in respect of its theological statement was probably closer to Bañez than to Molina. Again, only further textual evidence will confirm this conjecture.

To what extent then did Bernoulli consider our will free? According to Edith Sylla, there are traces that suggest that, despite God’s omniscience and omnipotence, Bernoulli granted us true freedom of choice. There is direct textual evidence in this respect in his 1682 *Conamen adornandi novi systematis cometarum*. The subject under discussion was whether the possibility of predicting the return of a comet, understood as an omen announcing punishments for our sins, implied that our fate was sealed. I.e., since we can anticipate when the announcement of divine punishment will take place, the deeds causing such punishment will necessarily occur. If God can anticipate our sins, is He not somehow responsible for them? Here is Bernoulli’s response:

If God infallibly knows the future sins of the world in such a way that his foreknowledge does not necessitate or act with force on mortal will, how much less will our foreknowledge of future evils, if we have such knowledge, necessitate, given that the sinful wills of men do not depend on us just as they do not depend on God. Or if the prophets’ foreknowledge of future evils, derived

¹⁹ Bernoulli became a close friend of Werenfels’ son, Samuel, an outstanding theologian and University professor himself, who wrote extensively on the issues discussed above, and was equally in favour of the doctrinal unity among protestant churches. They exchanged a number of letters: cf. [Weil *et al.*, 1993, 201-07]. However, according to [Sylla, 2006, 351], by 1672 Bernoulli was taking notes from Gernler regarding predestination in quite a different spirit (Basel University, MS LI a 4).

from the immediate revelation of God, did not necessitate, why, I pray, would our foreknowledge derived by natural light necessitate? [Sylla, 2006, p. 107]

Sylla argues that Bernoulli's theological position could be approximated through several contemporary texts. Sylla provides some quotes [pp. 352-53] of the Second Helvetic Confession, adopted in Basel in 1644, where our free will regarding *external things* is affirmed. She also quotes J. Wollebius' *Compendium Theologiae Christianae* (1626), that Bernoulli read in 1676, where the contingency of secondary causes is affirmed and the necessity of the divine decrees is affirmed to be *of immutability*, rather than *of coercion* [Sylla, 2006, p. 352]. This distinction is explained in some excerpts from Turretin's *Institutio Theologiae Elenctica* (1688) [pp. 355-57], whose first edition was published a decade after Bernoulli visited him in Geneva. According to Turretin, our actions are determined «extrinsically from an immutable decree», which does not eliminate contingency from the secondary causes, since their nature is not changed.

The event is necessary from the divine standpoint and in relation to the decree, but contingent from the standpoint of the creature and in relation to secondary and proximate causes, which could have been different [p.357]

Does this evidence contradict our position? We do not think so, if the following considerations are taken into account. First, we should note that both Catholics and Protestants agreed on their fundamental understanding of our actions: God takes active part in our decisions, without assuming responsibility for our sins. In Catholic theology, this was captured for instance by the distinction between efficacious and merely sufficient concurrence, as we already saw. It would be worth exploring how the Calvinist theologians in Basel understood such distinction. But it seems clear that they did, since, as Bernoulli put it, the sinful wills of men «do not depend on God». Yet, this does not imply that they are not causally related to His decisions.

Another way to address this dependence is through the analysis of how the Creation took place. The causal action of God stems from His knowledge and will. Molina's solution was to separate the former from the latter, so that knowing something did not necessitate its actual taking place. Yet, as Turretin put it in the passage quoted by Sylla, such separation is not something that a Calvinist can admit at face value [Sylla, 2006, p. 357]. Once the world is created, we may say it to be contingent, but

only from the standpoint of the creature. Which is precisely what Leibniz was contesting, adopting a Molinist stance: contingency should be real from the standpoint of the Creator Himself.

In what sense then could Bernoulli understand our will to be free? He was certainly neither an Aristotelian, for whom there was real contingency in nature that no superior being could foresee, nor a forerunner of Kant, who could have assumed unconditioned moral agency on our part. The freedom that he could have granted to our will is just the minimum required to make us accountable for our sins, with no implication of real contingency in our choice and sufficient causal power on our part to achieve any alternative by ourselves.

4. THE SECULARISATION OF THE MORAL SCIENCES

Almost from the inception of mathematical probability, the classical probabilists had hoped that their calculus would mathematize what were then called the moral sciences: jurisprudence, political economy, and other studies of social relationships. Part IV of Jakob Bernoulli's *Ars Conjectandi* (1713) was the first full-dress attempt to realize this hope. [Daston, 1988, 296]

The Bernoullis were a family of Protestant refugees who came to Basel in 1622, almost a century after its religious reformation, when Calvinist orthodoxy prevailed. To comply with the will of his father, who wanted him to become a pastor, Bernoulli graduated in theology at the University of Basel —that had become a protestant institution as soon as 1532. He held a number of relevant teaching and administrative positions at it, and could be considered —as Fritz Nagel put it— an *insider*. According to Battier's *Vita*, Bernoulli never ceased to study theology [Battier, (1705) 1744, 11] and when he travelled he usually got in touch with other protestant intellectuals, and

counted some among his closest friends. In Basel, Bernoulli was considered a devoted member of the church²⁰.

Calvin had defended an extremely demanding doctrine on the control that God exerted on every event. Of equal rigor were his thesis on the original sin and how it had affected our capability to discern the right and good. Without divine help, be it in the form on natural or revealed law, we could not expect to make the correct moral choice [García Alonso, 2006a, 2006b]. This is why the interpretation of the Bible became so crucial to arrange all practical matters in protestant communities. Basel had been no exception: under Johann Jakob Grynaeus, another University professor chosen *antistes* in 1585, Calvinist orthodoxy had been put under the control of the city magistrates. Only in the early 1700s an alternative view emerged, promoted significantly by Samuel Werenfels: an enlightened orthodoxy (*vernünfftige Orthodoxie*) that acknowledged that some truths could be discerned by our reason alone, even if the Bible was still needed to complete and confirm them.

Bernoulli was somehow caught in between traditional and renewed orthodoxy. According to the former, the use of the AC to help us to discern the morally correct, capturing «all the wisdom of the philosopher and all the prudence of the statesman», might have granted too much to our natural capabilities. As Pascal put it, «l'ardeur des saints à chercher le vrai était inutile si le probable est sûr» (*Pensées*, Br. 721, La. 917). On the other hand, it is not quite evident how to grant a Biblical foundation to the conclusions we reach through the AC. Perhaps Bernoulli thought that they would always be theologically safe, since they depended on an assumption entirely concordant

²⁰ «In frequentando divino cultu, quantum per valetudinem poterat, frequens erat & attentus, & quantum a superstitione, tantum a profano illorum studio, qui de Deo rebusque divinis contemtin sentiunt aut loquuntur, atque remotus» [Battier, (1705) 1744, 26]. Fritz Nagel illustrated many aspects of Bernoulli's daily life in his contribution to the Paris 2005 conference on *L'art de conjecturer des Bernoulli*: «The unknown Jacob Bernoulli. Some aspects of the non-mathematical activities of a mathematician».

with the most radical theses on predestination. We may now wonder whether, in this case, the secularisation of the moral sciences required just dispensing with this assumption, leaving behind an array of theological controversies still unresolved in our days²¹.

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²¹ The fact that the AC was aimed at lay audiences, according to [Sylla, 2006, 13-18] suggest that this might have well been the case.

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