‘Uncertainty over Risk’ to Lead China's Growth Transformation; Theoretical Basis to Reassess Investment Spending in National Income Simulations

Tomas Casas i Klett

Assistant Professor
University of St. Gallen, Research Institute for International Management,
Dufourstrasse 40a 9000 St. Gallen, Switzerland

Abstract

China plans the next steps of its remarkably successful economic transformation include innovation-based endogenous economic growth. Policy-makers across the world aim to generate endogenous or Schumpeterian growth to complement the better understood mainstream varieties of growth; Smithian (trade) and Solovian (capital investment). Schumpeterian growth is associated with the undertaking of uncertain investments with Knightian Type III unknown probabilities. Uncertainty undertakers, investors in innovation, generate true or naïve profits and hence economic growth beyond existing production-possibilities frontiers. Facing the ‘unknown’ makes this investment type distinct; investors will rely (to degrees significantly higher than their risk-return investor paradigm peers), on decision-making supported by behavioural (including non-rational) premises. This paper suggests that along with encouraging endogenous Schumpeterian growth, policy-makers must first develop methods to measure this distinct economic activity associated with investment flows in the discrete uncertainty-(naïve) profit paradigm. These flows ought to constitute their own category (distinct from classical risk-return investments), while being a constitutive part of the investment spending function of national accounts.

The *Investment (I) Separation Theorem* postulates two types of investment classes. On one hand, the type of growth resulting from investment in inputs (capital and labor as specified in mainstream economic models). On the other hand, endogenous Schumpeterian growth resulting from innovation. That is, [I = I(u) + I(r)], where [I(r)] represents investment in risk-return projects and [I(u)] investment in uncertainty-profit

projects. The GDP spending function [Y = C + I + G + NX] is also the result of past deconstruction (e.g., Marshall did not distinguish between consumer and investment spending). Entrepreneurship (including *intra*-preneurship, whether corporate or governmental) in its innovative high-growth variety, is the economic activity leading to endogenous growth, and at present it is not measured separately in economic models. In [I(u)] we have an independent (and actionable) variable standing for endogenous growth in econometric simulations. For China's economic policy-makers this approach to national income modeling, could yet be another method to manage the next stages of economic transformation towards an innovation-based economy relying on Schumpeterian growth.

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Debating points

1) Should academic efforts be spend in developing an national income modeling approach to incorporate a distinct 'Entrepreneurship Investment' function, with the aim of specifically distinguish investment in entrepreneurial activities from investment in non-entreprenerial activities?

2) Could a national income modeling approach with a distinct 'Entrepreneurship Investment' function support policy-makers in countries (like China) in their economic transformation efforts towards an innovation-based economy relying on Schumpeterian growth?

3) Should economic policy-makers lead the implementation a new approach to national income (GDP) modeling and the dissemination of associated data?

I. Types of Economic Growth

"Schumpeter is a sort of patron saint in this field. I may be alone in thinking that he should be treated like a patron saint: paraded around one day each year and more or less ignored the rest of the time."[1] Robert M. Solow

It is well known that trade generates economic growth, through a specialization process described by Adam Smith. Growth based on trade has been called Smithian growth and can be illustrated by the increase of economic output that occurred during Song Dynasty China between the 9th and 12th countries AD. Song China transitioned from a subsistence economy to a level of development not surpassed until the industrial revolution, the consensus being that the national waterway network constructed between 805 AD and 1075 AD allowed for the commercialization of Chinese society.[2] That is, Smithian growth resulting from a 'critical mass' of market linkage density enabled the transition from an economy characterized by a multitude of atomized economic agents and a limited division of labor, to a large highly specialized, integrated and growing market.[3]

While a variety of other growth types might be identified, the two growth categories complementing Smithian growth are Schumpeterian innovation and Solovian capital accumulation.[4] Eventually Smithian growth approaches a limit. Once all areas have become integrated into a unified market, growth through further specialization is no longer possible and the marginal benefits of trade decrease.[5] While China has probably not squeezed all the Smithian growth potential from trade and specialization, either domestically or internationally, it has reached a development stage where the Solovian variety is its main source of economic growth.

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[1] Robert M. Solow, "Perspectives on Growth Theory", *The Journal of Economic Perspectives*, Vol. 8, No. 1 (Winter 1994), p. 52.

[2] Morgan Kelly, "The Dynamics of Smithian Growth", *Quarterly Journal of Economics*, Vol. 112, No. 3 (August, 1997), pp. 940, 952.

[3] Ibid., pp. 939, 947.

[4] Joel Mokyr in *The Lever of Riches: Technological Creativity and Economic Progress*, Oxford University Press, 1990, pp. 4-6 citing Parker, describes Schumpeterian, Solovian and Smithian growth, along with economic growth based on economies of scale, or scale effects.

[5] Morgan Kelly, "The Dynamics of Smithian Growth", *Quarterly Journal of Economics*, Vol. 112, No. 3 (August, 1997), pp. 948-9.

Solovian growth with the well-known identity Y=f (K, L) sees output increases resulting from capital and labor inputs, the production function representing existing technological possibilities.[6] China's investment spending as a percentage of GDP more than doubles developed economies. The number of participants in its labor force has increased dramatically, as reflected by the generalized increases in wages and tightening labor markets. As the Solovian production function reaches its limit (where marginal increases of K and L inputs do not translate into equivalent output increases), a transition from an input investment spending growth model to an entrepreneurial innovation based economic model might be in order.

It has been suggested that only beyond a per capita income level of about USD 20,000 do "increasing levels of entrepreneurial activity benefit economic growth."[7] While China is still far from this level, or from the USD 17,000 GDP per capita threshold at which the middle-income trap is deemed to lurk, the Solovian growth engine might soon hit a limit. Solovian growth ceases to be a principal growth engine once all the capital investments for a certain production-possibility frontier have been realized, in the same way that Smithian growth slows once all possible theoretical trade relationships have been established. Transforming the economy to endogenous or Schumpeterian growth based on entrepreneurship and innovation, is the natural option for policy-makers once the exhaustion of Smithian and Solovian growth avenues has been ascertained.

In the 1980s a variety 'endogenous growth' theories that were complementary to neoclassical growth theory came to the forefront with economists like Lucas (1988) and Romer (1986).[8] These theories posit that growth also emanates from the innards of the economic system, knowledge being the key inside force. Romer's models seek equilibrium and emphasize the size of a given market on economic growth rates, with market size being determined not by the number of labor inputs but by accumulated human capital stock.[9]

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[6] Robert M. Solow, "A Contribution to the Theory of Economic Growth", *The Quarterly Journal of Economics*, Vol. 70, No. 1 (February 1956), p. 66.

[7] Andre van Stel, Martin Carreeand and Roy Thurik, "The Effect of Entrepreneurial Activity on National Economic Growth", Papers on Entrepreneurship, Growth and Public Policy, Max Planck Institute, 2005, p. 14.

[8] Phillipe Aghion and Peter Howitt, "A Model of Growth through Creative Destruction", *Econometrica*, Vol. 60, No. 2 (March 1992), p. 323.

[9] Paul M. Romer, "Endogenous Technological Change", *Journal of Political Economy*, Vol. 98, No. 5 (October 1990), Part 2, pp. S71, S98.

In its origins the endogenous growth variety has been linked to Schumpeterian creative destruction and the pursuit of institutionally sanctioned monopoly rents by innovators that last until the next innovation.[10] Solow questions the concept of such 'innovation' even as it 'captur(es) the attention of growth theorists'.[11] Yet if Solow were to formally suggest a "theory of easy endogenous growth" it would be one where more R&D creates new growth, albeit these greater R&D resources are allocated "as a result of decisions made by firms" who buy "a one-time jump in productivity".[12] This process would impact economic growth in a manner not unlike the impact of demographic growth or the addition of labor inputs. This is a different position from Austrian economics that sees a theoretically distinct role for entrepreneurship and its attendant innovation in the economy. Austrian human choice assumptions include imagination, boldness and surprise.[13] The centrality of firm founder actions on the economy and its cycles is a known tenet Schumpeterian thought. Theoretical development around endogenous growth in this paper is consistent with bringing the "forgotten child of economics, namely entrepreneurship"[14] back into the central position in economics it once claimed. Richard Cantillon with his *Essai sur la nature du commerce en general* (1755), Jean-Baptiste Say (1803) and John Stuart Mill (1884) did to varying degrees incorporate firm founders into economic science.[15]

Solow does not negate "the partially endogenous character of innovation" and admits that endogenous technology based growth is not "a simple matter of inputs and outputs" yet he also questions the ability to model such growth.[16] Nonetheless there have been important theoretical efforts in this direction and Dinopoulos and Sener point to a 'second generation' of scale-invariant Schumpeterian growth models that could yield "unified growth theory that combines the robustness and

[10] Phillipe Aghion and Peter Howitt, "A Model of Growth through Creative Destruction", *Econometrica*, Vol. 60, No. 2 (March 1992), p. 349.

[11] Robert M. Solow, "Perspectives on Growth Theory", *The Journal of Economic Perspectives*, Vol. 8, No. 1 (Winter 1994), p. 53.

[12] Ibid.

[13] Israel Kirzner, "Entrepreneurial discovery and the competitive market process: An Austrian approach," *Journal of Economic Literature*, Vol. 35, No. 1 (March 1997), pp. 60-85.

[14] Thomas Hellmann, "Entrepreneurship and the Process of Obtaining Resource Commitments", *Graduate School of Business Stanford University Website*, (2000) p. 23. Available at: https://gsbapps.stanford.edu/researchpapers/library/RP1704.pdf

[15] Mark Casson, *The Entrepreneur: An Economic Theory*, Northampton: Edward Elgar, 2003, p. 32.

[16] Robert M. Solow, "Perspectives on Growth Theory", The Journal of Economic Perspectives, Vol. 8, No. 1 (Winter 1994), p. 52.

empirical relevance of the neoclassical growth model and the Schumpeterian mechanism of creative destruction."[17]

While exogenous growth might be difficult to model, and its impact on overall growth is not unanimously agreed by entrepreneurship scholars, theoretically it constitutes a third type of growth. Or a second type if we group both Smithian and Solovian forms of growth as endogenous. At the same time, the three varieties of growth are not mutually exclusive and constantly reinforce each other. For instance, Romer cites Sokoloff's (1988) historical data where counties in 19th century America with access to waterways enjoyed higher levels of innovation (the proxy being patents).[18] This would be Smithian growth leading to proto-Schumpeterian growth.

The PRC, throughout the different levels of administration, is already implementing policies to encourage high-impact innovation. For instance, those described in the *Medium- and Long-Term National Plan for Science and Technology Development*. One specific line of action is promoting the production of intellectual property (IP) since private firms have "produced inadequate number of core patents" and "their capacity to utilize patent(s) is poor." Thus "The National Patent Development Strategy [2011-2020] is a long-term and overall plan for enhancing China's core competitiveness by making use of patent system and resources." In terms of targets the state is not timid: by 2015 the applications of patenting inventions should double to 2 million.[19]

Besides the top-down approach, millions of Chinese entrepreneurs are constantly innovating on their own pushed on by markets and customers. Entrepreneurship is why China, with historically relatively low levels of R&D expenditure, has grown so fast.[20] And yet is the 'typical start-up' were not innovative it would not generates much wealth as "economic growth and jobs creation from entrepreneurs is not a numbers game. It is about encouraging the formation of high quality, high

[17] Elias Dinopoulos and Fuat Sener, "New Directions in Schumpeterian Growth Theory", in Horst Hanusch and Andreas Pyka, eds., *Elgar Companion to Neo-Schumpeterian Economics*, Edward Elgar, 2007, p. 14. Available in http://bear.warrington.ufl.edu/dinopoulos/pdf/schumpeteriangrowth.pdf

[18] Paul M. Romer, "Endogenous Technological Change", *Journal of Political Economy*, Vol. 98, No. 5 (October 1990), Part 2, pp. S98.

[19] China State Intellectual Property Office, 2010. "National Patent Development Strategy (2011-2020)". Released at a press conference in Beijing on November 11, 2010, available at: http://graphics8.nytimes.com/packages/pdf/business/SIPONatPatentDevStrategy.pdf

[20] Maria Minniti and Moren Lévesque, "Entrepreneurial Types and Economic Growth", *Journal of Business Venturing*, Vol. 25, No. 3 (2010), pp. 306.

growth companies."[21] While the Chinese government and scholars might argue that private firms' efforts and resources are insufficient in terms of generating cutting-edge technology products and services or sophistical forms of social innovation, such an assessment is not within the scope of this discussion. The purpose of this paper is neither to review policies, nor to advocate endogenous growth. Rather its goal is to develop a theoretical understanding of endogenous Schumpeterian growth, so that policy-makers who wish to encourage it can start by identifying endogenous growth related investments as a distinct element of the national accounts function. That is to incorporate 'high-quality' endogenous growth into the most essential equation describing the national economy.

II. Uncertainty: anchor of endogenous growth, innovation and profits

Romer (1990) qualifies endogenous models on the basis of decision-makers responding to market incentives.[22] More extreme models of the endogenous would be based on Say's Law, generally understood as 'supply creating its own demand'. That is, Austrian economics and theories that give 'imagination' a central role, as does Schackle (1970) when he talks about the founder: "The inescapable and perhaps wide ranging plurality of the ideas which (the entrepreneur) can plausibly form about the sale proceeds of future outputs and the expense of future inputs can be dealt with only by his own judgment."[23] Supply creating its own demand does presuppose the uncertainty paradigm because of demand's non-existence when supply is imagined, or even when supply hits the market.

All investment spending is preceded by decisions to spend, which in turn are made by individuals commanding the resources of organizations. Risk and uncertainty are distinguishable by the fact that in risk there is *a priori* knowledge of the outcome probabilities. Knight's groundbreaking *Risk, Uncertainty and Profit* (1921) was the first work that dealt explicitly with decision-making under

[21] Scott Shane, "Why encouraging more people to become entrepreneurs is bad public policy", *Small Business Economics*, Vol. 33, No. 2, (2009), p. 141.

[22] Paul M. Romer, "Endogenous Technological Change", *Journal of Political Economy*, Vol. 98, No. 5 (October 1990), Part 2, pp. S72.

[23] George L. S. Shackle, *Expectation, Enterprise and Profit*, London: George Allen and Unwin, 1970, p. 28 cited in Stephen Batstone and John Pheby, "Entrepreneurship and decision making: the contribution of G.L.S. Shackle", *International Journal of Entrepreneurial Behavior and Research*, Vol. 2, No.2 (1996), p. 47.

uncertainty, and it provided a clear theoretical distinction between uncertainty and risk. He saw three types of events associated with distinct types of probabilities:[24]

(I) 'Type I' or '*A priori*' probability: Chances can be computed on a general principle. This probability is on the same logical plane as mathematical propositions.

(II) 'Type II' or 'Statistical' probability: Chances can be determined empirically and are measured on the basis of precedent and the empirical classification of instances.

(III) Simply 'Type III' probability: True uncertainty is unmeasurable. There is no valid basis for classifying unique, unprecedented instances. Yet a judgment of probability, a subjective biased estimate, is made in most cases and provides the guide to decision-making.

Type I events are mostly irrelevant for business. Type II probabilities are critical for rational decision-making in investment situations and relate to risk. Risk, in modern portfolio theory, is measured by variance or by standard deviation and "is associated with the financial notion of return."[25] Investors in their portfolios will balance given or mean levels of return with risk, that is with Knightian Type II statistical probability.

Type III or "Knightian uncertainty" can, on the other hand, not be known and thus is discerned with the aid of subjective biases underpinning decision-making. In other words Type III leads to non-optimization, anomalies and even non-rationality. Thus unsurprisingly, McDonald and Siegel (1986) demonstrate that "moderate amounts of uncertainty (…) could more than double the required rate of return for investments."[26] But by how much would the return increase for normal or large amounts of uncertainty? With unmeasurable uncertainty this questions is impossible. Solow (1994) readily confirms that "Knightian uncertainty" which is non-probabilistic (and admittedly "surrounding many research projects") is devoid of "appropriate analytical techniques".[27]

[24] Frank Knight, *Risk, Uncertainty and Profit*, Washington DC: Beard Books, [1921] 2002, pp. 212, 225, 226, 231, 232, 233.
[25] Harry M. Markowitz, "Foundations of Portfolio Theory", Nobel Lecture, December 7, 1990, p. 280.
[26] Robert S.Pindyck and Andres Solimano, "Economic Instability and Aggregate Investment", The World Bank Working Paper No. 3552-93-EFA (April 1993), p.1.
[27] Robert M. Solow, "Perspectives on Growth Theory", *The Journal of Economic Perspectives*, Vol. 8, No. 1 (Winter 1994), p. 52.

Uniqueness lies at the core of entrepreneurial and innovative projects, as it does lie at the core of uncertainty and invalidates the probabilistic and the aggregate (macro) approaches to decision-making where like-events provide statistical reference and standard distributions (Type II statistical probabilities). Uniqueness forces a transition to a statistically reference-less perspective. It forces biased, very personal, subjective judgments that depart from rational guidelines. That is, investments that are unique (in innovation, entrepreneurial or intrapreneurial) move us from the risk-return 'statistical' Type II probability paradigm to the uncertainty paradigm with a Type III or 'unknown' probability. The statistical uniqueness of an investment in innovation (leading to endogenous growth), its unprecedented nature, causes it to be intrinsically uncertain. Lastly, the natural uncertainty present in statistically reference-less investment decisions is further exacerbated extrinsically; the field of behavioral economics shows us that decision-making under uncertainty generates further uncertainty. Or as Karayiannis points out "the entrepreneur through his actions, (rather indirectly) increases the uncertainty, confronted by other entrepreneurs, by consumers and by property owners."[28]

Schumpeterian or endogenous growth based on innovation is characterized by investments inextricably linked to Knightian uncertainty, carried out by entrepreneurs and intrapreneurs who rely on subjective personal judgments and their imagination.

III. Endogenous Growth as Investment under Uncertainty Behavior

Schumpeter and most Austrian economists do not ground their theoretical insights in the cognitive and motivational aspects of human behavior. Nor did Keynes provide an endogenous theoretical framework for his 'animal spirits' despite his recognition that spirits impacted key economic variables in his models. While behavioral economics original vocation is not the investment spending function (I) of the economy (Y), it could supply a decision-making framework that is both alternative and in opposition to the models of rationality and optimization that underpin investment and mainstream economics.

[28] Anastassios D. Karayiannis, "The entrepreneurial function in economic literature: A synoptic review", *Rivista Internazionale di Scienze Economiche e Commerciali*, Vol. 37, No. 2 (1990), p. 260.

Rooted in psychology, this body of theory was articulated by Kahneman and Tversky (1979)[29], and others who did enhance the bounded rationality work of Simon (1955) where individual judgment is bounded in its rationality mainly by cognitive limitations.[30] Behaviorist models include cognitive elements and also establish that motivational factors cause decision-makers to depart from classical rationality. Experimental observation of judgment anomalies (deviations from rational choice theory), such as those described in the biases and heuristics program, has enabled the specification with high degrees of granularity of behavioral decision-making processes conflicting with optimization, rationality and the application of probabilistic analysis to investment decisions, and of decision-making underpinning investments in innovation and entrepreneurship.

Heuristics are mental shortcuts, simplifying strategies that individuals use to make decisions, especially in uncertain and complex conditions.[31] Heuristics lead to biases.[32] Biases are the visible departures from the normative rational theory.[33] Behavioral factors (such as biases, heuristics) are over-represented in investment decisions under uncertainty, thus extrinsically increasing the natural or intrinsic uncertainty of decisional process. The natural intrinsic uncertainty of innovative precedent-less investment events is augmented by new extrinsic uncertainty, the result of decision-making in innovation.

Mirroring economic orthodoxy, the theoretical firms discussed in mainstream economics are basically all entrepreneur-less an omission akin to leaving the Prince of Denmark out of Hamlet.[34] Schultz notes that at most economic theory burdens the entrepreneur "with esoteric niceties the implications of which are

[29] Daniel Kahneman and Amos Tversky, "Prospect Theory: An Analysis of Decision under Risk", *Econometrica*, Vol. 47, No. 2 (March 1979), pp. 263-292.

[30] Herbert Simon, "A Behavioral Model of Rational Choice", *Quarterly Journal of Economics*, Vol. 69, No. 1 (1955), p. 101.

[31] Lowell Busenitz, "Entrepreneurial risk and strategic decision making: It's a matter of perspective", *The Journal of Applied Behavioral Science*, Vol. 35, No. 3 (September 1999), p. 327.

[32] Amos Tversky and Daniel Kahneman, "Judgment under uncertainty: Heuristics and biases", *Science*, Vol. 185, No. 4157, (September 1974), p. 1124.

[33] Thomas Gilovich and Dale Griffin, "Introduction - Heuristics and Biases: Then and Now", in Thomas Gilovich, Dale Griffin and Daniel Kahneman, eds., *Heuristics and Biases - The Psychology of Intuitive Judgment*, Cambridge: Cambridge University Press, 2002, p. 3.

[34] William Baumol, "Entrepreneurship in Economic Theory", *American Economic Review*, Vol. 58, No. 2 (May 1968), p. 66.

rarely observable."[35] At the national income macroeconomic theory level said burden is not even conveyed, and so in macroeconomic models and simulations entrepreneurial investments and comparable financial flows into innovation are not singled out. This paper's epistemological position is that Knightian uncertainty and the attendant behavioral/emotional decision-making processes are a distinct and internally consistent investment reality. The inclusion in economic models of investment flows in innovation, i.e., in entre/intrapreneurship, would support the accounting of endogenous growth.

Type III intrinsic uncertainty is associated with the pursuit of the unknown, which is compounded (becoming *less unknown* if that where possible) by extrinsic uncertainty resulting from less rational, highly emotional/behavioral decision-making. In short, investments under the uncertainty paradigm and subject to Knightian uncertainty Type III probability cannot be associated with the Solovian identity that 'increased R&D will result in increased growth'. Without the high behavioral emotional content of uncertain investments (ownership biases, passion, associative quick thinking), these unlikely-to-succeed investment bets have an even more miniscule chance of succeeding. These investments thus escape risk-return analysis and Type II probabilistic rational guides for investments. Hence the limited effects of government actions meant to encourage them. Lastly, the type of business investment flows driving high-quality endogenous growth and moving the Solovian production outward relies on naïve (or true) profits/losses as per Bronfenbrenner (1960).[36]

IV. Naïve profits: Uncertainty's Premium behind Exogenous Growth

It is generally understood that profits refer to 'net business income' the difference between revenues or turnover and the corresponding costs. Schumpeter (1934) noted that risks not foreseen or not taken into account in economic planning "become on the one hand sources of temporary loss and on the other hand sources

[35] Theodore Schultz, "Investment in Entrepreneurial Ability", *Scandinavian Journal of Economics*, Vol. 82, Issue 4 (1980), p. 437.

[36] Martin Bronfenbrenner, "A Reformulation of Naive Profit Theory", *Southern Economic Journal*, Vol. 26, No. 4 (April 1960) pp. 300-309.

of temporary gain."[37] This alternative notion of profits is consistent with Knight (1921) and Hawley (1893) who saw enterprise, and related risk-taking, rewarded with excess compensation, profits that are a distinct type of income.[38] That is, such income, gains, profits (and losses) are not predictable, since they are the result of uncertainty, the unknown 'Type III' probability. Schumpeter's notion of temporary gains and losses is consistent with Bronfenbrenner's (1960) reformulated Naïve Profit Theory, which sees entrepreneurship and its profits "as compensation for merely the subset of uncertainties which arises from having no contractual claim to one's income."[39] The 'pure profit' theory sees those making profits *indentured* to risk and to uncertainty.[40]

Some economists will question the idea of profit as a residual - and a random, unforeseen one at that - unrelated to value adding activity.[41] Could naïve profits instead not be a designation for high returns under high-risk exposure? Advocates of efficient VC (Venture Capital) 'capital markets' see higher returns offset by higher risk (Poindexter, 1976; Charles River Associates, 1976).[42] Others argue that the risk-return trade-off assumed by an entrepreneur investing heavily in his firm is far worse than the trade-off in the private equity index.[43] Naïve profits are *de facto* naïve because they are unforeseen and in most cases they turn out to be losses. One would expect investors in entrepreneurship (entrepreneurs as a class) to be compensated for their high exposure, but this turns out not to be the case.[44] For uncertainty undertaking based on innovation and leading to Schumpeterian growth, the risk-return paradigm is irrelevant.

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[37] Joseph Schumpeter, *Theory of Economic Development: An Inquiry into Profits, Capital, Credit, Interest and the Business Cycle*, Reprint edition, New Brunswick: Transaction Publishers, [1934] 2003, p. 33.

[38] Anastassios D. Karayiannis, "The American Apogee of Contributions on Entrepreneurship (1880s – 1920s)", *American Review of Political Economy*, Vol. 3, No. 2 (December 2005), p. 78.

[39] Martin Bronfenbrenner, "A Reformulation of Naive Profit Theory", *Southern Economic Journal*, Vol. 26, No. 4 (April 1960), pp. 300-309 cited in Israel Kirzner, *Competition and Entrepreneurship*, Chicago: University of Chicago Press, 1978, pp. 76-77.

[40] Theodore Schultz, "Investment in Entrepreneurial Ability", *Scandinavian Journal of Economics*, Vol. 82, Issue 4 (1980), p. 437.

[41] Ibid., pp. 437-448.

[42] Tyzoon Tyebjee and Albert Bruno, "A Model of Venture Capitalist Investment Activity", *Management Science*, Vol. 30, No. 9 (September 1984), p. 1052.

[43] Tobias J. Moskowitz and Annette Vissing-Jørgensen, "The Returns to Entrepreneurial Investment: A Private Equity Premium Puzzle?", *The American Economic Review*, Vol. 92 No. 4 (September 2002), pp. 745-778.

[44] Scott Shane, *The Illusions of Entrepreneurship: The Costly Myths that Entrepreneurs, Investors, and Policy Makers Live By*, Yale University Press, 2008.

With uncertainty it is not possible to know neither the magnitude nor the associated variability of the likelihood of profit (or the more likely loss). Entrepreneurs engage uncertainty on the strength of their emotions, specially the ownership bias, and other high subjective and non-rational guides of judgment.

Several authors "(e.g., Ellsberg, 1961; Fellner, 1961; Keynes, 1921; Knight, 1921) distinguished among uncertain prospects according to the degree to which the uncertainty can be quantified. At one extreme, uncertainty is characterized by a known probability distribution; this is the domain of decision under risk. At the other extreme, decision makers are unable to quantify their uncertainty; this is the domain of decision under ignorance."[45] The graph below depicts the 'risk-to-uncertainty' continuum' which is based on the distinction between knowable and uncertain prospects; different types of investment categories are positioned along the continuum.

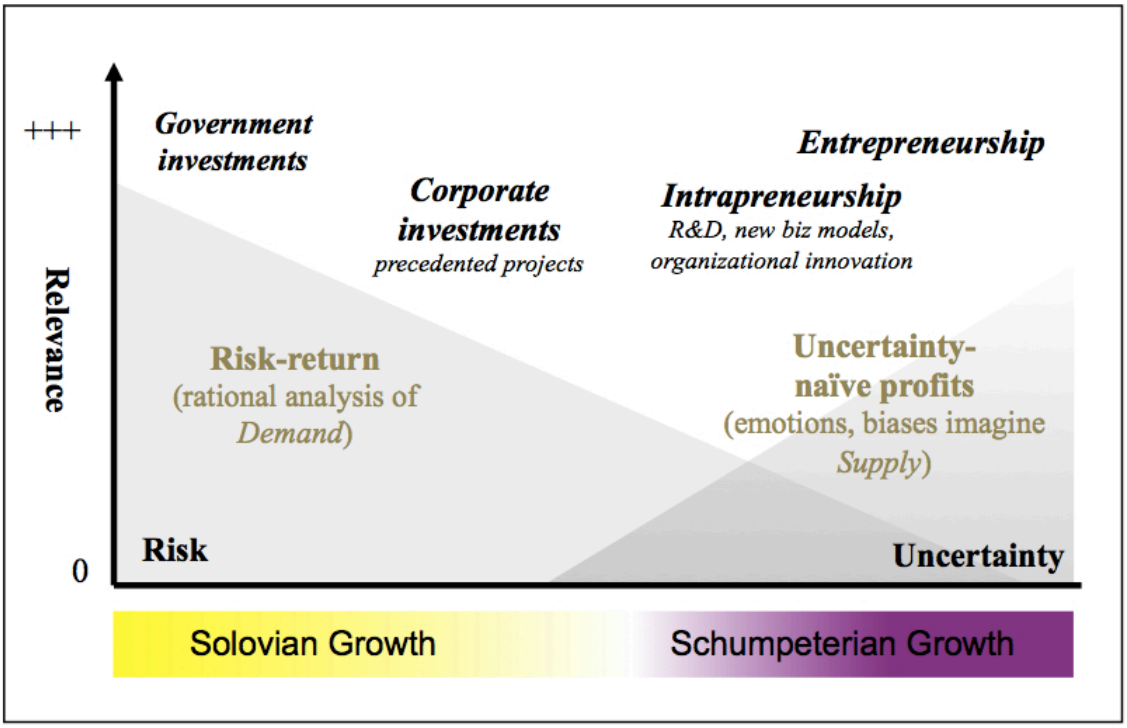

Figure 1: Investment types positioned along the risk-uncertainty continuum[46]

[45] Amos Tversky and Craig Fox, "Weighing Risk and Uncertainty", in Daniel Kahneman and Amos Tversky eds., *Choices, Values, and Frames*, Cambridge: Cambridge University Press, 2000, p. 116.

[46] Adapted from Tomas Casas, *K-Efficiency Theory of Entrepreneurship: Random Payoffs, Biases and Bounded Luck*, Difo-Druck GmbH, Bamberg 2005, p. 552.

Figure 1 places investment types along two extremes of a continuum. Some investments are more reliant on Type II probabilities allowing for rational analysis of demand (leading to exogenous Solovian growth), while others rely on Knightian uncertainty where imagination fuels supply to create its own demand (and leading of endogenous Schumpeterian growth).[47] Individuals or companies who, on the basis of dreams or over-optimism, pursue naïve or true profits by undertaking uncertainty, uniqueness and hence make unprecedented investments, are subject to the uncertainty-naïve profit paradigm. Figure 1 describes the fact that at the uncertainty end of the risk-to-uncertainty investment continuum, the risk-return model offers scant guidance for investing decisions; gains and losses are random, since they are the result of the unknown Type III probability. It is important to note that a majority of "decisions under uncertainty lie somewhere between these two extremes: People typically do not know the exact probabilities associated with the relevant outcomes, but they have some vague notion about their likelihood." [48] We posit that it is possible to distinguish two types of investment categories on the basis of Knightian theory. That is, investments closer to the risk-return paradigm [I(r)] or to the uncertainty-profit paradigm [I(u)].

In summary, uncertain investments yield a special kind of unknowable return, which theorists have conceptualized as 'pure or naïve profit.' This profit resulting from successful market adoptions of innovations constitutes the economic basis of endogenous growth. Aggregation, like that practiced by VCs or society as a whole can convert uncertainty into risk but this technique is not available to the individual or firm directly engaging with uncertainty (it is available only the higher aggregate level). The emotional, optimistic and biased investment behavior based on dreams and visions constitute the I(u) flows in the economy which lead to supply creating its own demand and to endogenous Schumpeterian growth.

[47] Note: In Figure 1 the relationships between relevance and the degree of risk / the degree of uncertainty are depicted in linear form, this depiction being a simplification.

[48] Amos Tversky and Craig Fox, "Weighing Risk and Uncertainty", in Daniel Kahneman and Amos Tverskyeds., *Choices, Values, and Frames*, Cambridge: Cambridge University Press, 2000, p. 116.

V. Modeling Endogenous Growth: Splitting the (I) Investment Function

The most common approach to measuring and understanding GDP is the expenditure method where GDP *equals* consumption *plus* investment *plus* government spending *plus* net exports (exports *minus* imports), formulated as $Y = C + I + G + NX$. The left hand side of the equation is the value of the total output or national income; the right hand side represents aggregate expenditure.

After consumption (C), investment spending (I) is the second largest component of GDP in most countries. In China gross capital formation has since 1978 been exceedingly high, even when compared to other Asian countries at similar stages of development, leading to worries of excessive investment (I) and the perennial fear of abrupt corrections.[49] National accounting of investment spending (I) is constituted by three categories: (a) business investment or nonresidential investment spending (includes all goods supporting production processes such machinery, offices and buying goods to sell); (b) residential investments (i.e., household spending on buildings); (c) business inventories (i.e., stored goods to be sold later). Investment (I) accounted for a 44.82% slice of GDP in the China in 2010, with consumption (C) being 34.79% and government spending (G) 16.9%; by contrast Investment (I) in the US was 19.86% while in Japan 23.72%.[50]

Any increases in investment activity (I) by businesses (triggered, for instance, by lower interest rates) will increase aggregate demand and the growth rate of GDP. In econometric modeling, investment (I) is autonomous of real GDP. Variables like real interest rate changes and expected real profits affect investment (I) levels. The investment level (I), that is, the decision to invest by businesspersons, is dependent on the expected real return rate in mainstream economics. Investment (I) assumes a rational, probabilistic risk-return relationship to which money capital is exposed along the efficient frontier and with the relationship to the alternative use of capital, such as the holding of interest bearing securities (bonds). In other words, I=I(r).

[49] Lee Il Houng, Murtaza Syed and Liu Xueyan, "Is China Over-Investing and Does it Matter?", IMF Working Paper, Asia and Pacific Department (November 2012), p. 3.

[50] On the basis of PPP Converted GDP Per Capita at current prices, in Alan Heston, Robert Summers and Bettina Aten (2012): Penn World Table Version 7.1, Center for International Comparisons of Production, Income and Prices at the University of Pennsylvania, July 2012

We explore the possibility that within the business investment category of the investment (I) function of national income (Y), two distinct investment flows coexist. The flow I(r) results from the rational choice class of decision-making. That is, when businessperson allocate capital based on rational and objective probability and risk calculations about the return potential of their investments. Both Keynesian and neoclassical perspectives assume that statistical analysis offers adequate guidance to businesspeople and enables them to approximate the variances associated with their I(r) investments. Investment decisions can thus be made on the basis of expectations.

A second flow within (I) would constitute capital invested not in risk-return projects, but rather in Type III projects characterized by decision-making under uncertainty. Such investments might result in innovation rents and in naïve profits. The two investment types are sufficiently distinct and internally consistent categories to warrant separate consideration. Below the assumptions needed for a putative (I) Separation Theorem:

***Investment (I) Separation Theorem* Assumptions**
Assumption I: Investment flows I(r) based on rational risk-return investment analysis by economic agents cause Solovian exogenous growth.
Assumption II: Investment flows in uncertain undertakings I(u) which consequently rely on behaviorally biased (emotional) decision-making, might generate innovation rents; the aggregate of these naïve profits cause Schumpeterian or endogenous economic growth.
Assumption III: Total investment (I) flows in a given economy can be separated into distinct I(r) and I(u) flows.

Table 1: Investment (I) Separation Theorem fundamental assumptions

In short, an **Investment (I) Separation Theorem** would see I = I(u) + I(r), where [investment] equals [investment in risk-return projects] and [investment in uncertainty-(naïve) profit projects]. I(u) flows include both entrepreneurial activity

(uncertainty-undertaking by newly incorporated firms) and, intrapreneurial activity (uncertainty-undertaking by established organizations such as listed corporations and government). Thus I(u) = I(u-entre) + I(u-intra).

The Investment (I) Separation Theorem separates exogenous I(r) from endogenous I(u) growth. A new categorization of Y constituent variables is not unprecedented in economics and we might be tempted to draw here a historical parallel with Marshall, whose *spending function* did not make a distinction between consumer (C) and investment (I) spending.[51] It was Keynes who distinguished between these two flows and emphasized that they are not the same type of spending and this separation had implications on economic equilibrium, and is now part of mainstream theory. The distinction between the pursuit of return I(r) and the pursuit of profits I(u) within investment spending (I), might be similarly relevant to economic modeling.

The quality of the paper's assumptions and theoretical exploration would be determined by the articulation and eventual testing of hypotheses, intended to be *falsifiable* and refutable.[52] Some of the sample hypotheses proposed next would have implications for the management of endogenous economic growth.

Hypothesis I(a): Changes in I(u) will lead to changes in Y future growth.

Hypothesis I(b): Changes in Y growth resulting form changes in I(u) are distinct in size and associated time lag from the changes in Y caused by changes of I and I(r).

Monetary policy affects GDP and the growth rate of Y through interest rates, which create responses in borrowing by business and business investment (I) activity. Increases in interest rates cause investment (I) demand to decline. Lower interest rates reduce the cost and increase the profitability of borrowing through present value calculations and return expectations. These are all calculations anchored in rational calculation assumptions. Uncertainty undertaking grounded in behavioral factors, the ownership biases and emotions will be less rational and thus can be hypothesized to be less sensitive to interest rates. Is then the impact of interest rates changes on changes in I(u) investment flow levels less significant

[51] Robert Heilbroner, *The Worldly Philosophers: The Lives, Times and Ideas of the Great Economic Thinkers*, revised seventh edition, London: Penguins Books, [1953] 1999, pp. 308-9.

[52] Karl, Popper, *Conjectures and Refutations: The Growth of Scientific Knowledge*, Reprint edition, London: Routledge, [1963] 2002, p. 48.

than on changes of I(r) investment flow levels? Could this explain why monetary policy often fails to stimulate high-quality investment (I) spending by businesses?

Hypothesis II: The relationship between interest rates and I(u) is weaker than the relationship between interest rates and I(r).

The hypotheses reviewed are but some of many that would result from the Investment (I) Separation Theorem. The underlying assumption is that I(u) is measurable, an assumption whose limitation are to be examined next.

VI. Limitations: Measurement, Normative Aspects of Endogenous Growth

Keynes' diagnosis in *The General Theory of Employment, Interest and Money*, was that "*(…) prosperity depended on investment. (…) investment was an undependable drive wheel for the economy. Uncertainty, not assurance, lay at the very core of capitalism.*"[53] This paper takes issue with Keynes' both negative and non-actionable view of uncertainty in the business investment context. This view had far-reaching implications for prescriptive Keynesian economic growth policies. Uncertainty is what allows quality growth and Hicks pointed out that Knight "laid securely the first foundation on which any future theory of profits must rest - the dependence of profits on uncertainty."[54] Policy-makers aiming at generating quality economic growth will seek to stimulate economic activity associated with (naïve) profits. These will only accrue from investments in innovative activities within the uncertainty I(u) statistical paradigm. Most of the capital spending by established corporations or state institutions, including R&D, is not intrapreneurial (whether in statistical or in behavioral terms). It is related to precedent and to rational analysis and as such it generates returns associated with the term structure of interest rates and is subject to known variances. Such capital spending is part of I(r) flows in the economy; it is activated by Keynesian stimulus packages but it leads to limited endogenous economic growth.

From an economic policy perspective, it is important to distinguish between investments that might lead to endogenous growth and those that will not. Yet just

[53] Robert Heilbroner, *The Worldly Philosophers: The Lives, Times and Ideas of the Great Economic Thinkers*, revised seventh edition, London: Penguins Books, [1953] 1999, p. 273.
[54] John R. Hicks, "The Theory of Uncertainty and Profit", *Economica*, Vol. II, (May 1931) p. 170 cited in Anastassios D. Karayiannis, "The American Apogee of Contributions on Entrepreneurship (1880s – 1920s)", *American Review of Political Economy*, Vol. 3, No.2 (December 2005), p.88.

as different equilibriums between (I) and (C) flows in an economy impact a variety of economic variables and outcomes, we may find that different ratios (equilibriums) between I(r) risk-return exogenous investments and I(u) uncertainty-profit endogenous investments are meaningful in terms of modeling and predictability. That is, the relative weight of return-seeking and naïve profit-seeking investments by businesspeople within an economy may possess assorted implications for short- and long-term growth, for employment, and more specifically for productivity increases.

A proxy for measuring endogenous growth would be the 'risk-uncertainty investment ratio' or k-ratio, the *I(u)/I(r)* relationship.[55] Other formulations for approximating endogenous growth would be I(u)/I or even I(u)/Y. In both instances measurement problems would need to be overcome; since the I(u-intra) part of I(u) might be harder to measure than I(u-entre) a further simplification of the proxy could be; *I(u-entre)/Y*. A I(u-entre) proxy not exempt of obvious limitations could in turn be, *grosso modo*, the amounts of funds channeled to early-stage investments. While not necessarily a relevant approach in China were formal early-stage funding is relatively minor in comparison to informal early-stage funding, the *I(u-entre)/Y* relationship could be determined in advanced economies by early-stage VC data. On such basis the US and Canada's *I(u-entre)/Y* did average around 0.15% (between 1999 and 2002). In other counties it was significantly lower; in the Netherlands and the UK it amounted to 0.06%, while in Japan it was a tinny 0.01% (of GDP). Israel earned the global top spot with 0.36%.[56] Underdeveloped as these ratios are, the growth multiplier associated to them could be computed, thereby answering Solow question who while accepting that successful innovations could yield incremental growth, asked: "But how much larger?"[57]

A study of U.S. metropolitan areas found that increasing the supply of VC funds positively impacts aggregate income and employment.[58] By matching up the 30+ year portfolio company database of Dun & Bradstreet and Global Insight, the VC

[55] Tomas Casas, *K-Efficiency Theory of Entrepreneurship: Random Payoffs, Biases and Bounded Luck*, Difo-Druck GmbH, Bamberg 2005, pp. 623-624.

[56] OECD, "Science Technology Industry - Venture Capital: Trends and Policy Recommendations" (2004), pp. 6-7. Available at: http://www.oecd.org/dataoecd/4/11/28881195.pdf

[57] Robert M. Solow, "Perspectives on Growth Theory", *The Journal of Economic Perspectives*, Vol. 8, No. 1 (Winter 1994), p. 53.

[58] Sampsa Samila and Olav Sorenson, "Venture Capital, Entrepreneurship, and Economic Growth", *Review of Economics and Statistics*, Vol. 93, No. 1 (2011), pp. 338-349.

industry association showed that while VC investments "during the three-decade study period was less than 1% of the total investment scene, those companies which survived now made up roughly 10% of U.S. employment and had revenues greater than 10% of U.S. GDP."[59] Future research will have to corroborate whether endogenous Schumpeterian investment flows I(u) do have a disproportional positive effect on the economy's future growth (positive multiplier effect). The multiplier effects need stronger empirical support, theoretical definition and I(u) will require direct measurement, i.e., I(u-entre) + I(u-intra).[60]

What would direct accounting of I(u-entre) include? It could comprise all formal business angel funding, along some of the informal investment provided by family and friends to support new high-quality, high-potential entrepreneurial firms. A clear classification system would become of essence as for certain types of flows the I(u) and I(r) distinction is not obvious (e.g., projects like professional or lifestyle firms). On the intrapreneurial front I(u-intra), Dinopoulos and Sener point to the scale-effects property of early Schumpeterian growth models that relate R&D with growth in the long-term.[61] Yet R&D investments might not fit I(u) criteria of Knightian uncertainty and behavioral responsibility. In Japan, relatively high levels of R&D are not I(u-intra) and do not translate into endogenous growth; a significant part of Japanese R&D investments clearly belong to I(r). This is ironic because in mature industries "diminishing returns to investment increase the relative importance of technological progress."[62]

The limitations to the quantitative measurement of I(u-intra) flows arise from the fact that these are not invariably the result of genuine entrepreneurial (or *intra*preneurial) mindsets but rather of corporate, rational process. Surveys measuring I(u) could require adjustments or weightings on the basis of a taxonomy of investment flows within I(u); early stage VC investments could be weighted at let's say 90% * I(r), corporate R&D at 50%, government R&D at 30%. Further empirical and conceptual development work is necessary.

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[59] National Venture Capital Association (2005), "Year in Review 2004-2005 - Poised for success", p. 33. Available at: http://www.nvca.org/pdf/yir-04-05-web.pdf

[60] The aim is to avoid reducing I(u) again to being a residual as it would if it were derived through; [I(u)=I - I(r)].

[61] Elias Dinopoulos and Fuat Sener, "New Directions in Schumpeterian Growth Theory", in Horst Hanusch and Andreas Pyka, eds., *Elgar Companion to Neo-Schumpeterian Economics*, Edward Elgar, 2007, p. 14. Available in http://bear.warrington.ufl.edu/dinopoulos/pdf/schumpeteriangrowth.pdf

[62] Elliot Parker, "Schumpeterian Creative Destruction and the Growth of Chinese Enterprises", *China Economic Review*, Vol. 6, No. 2 (1995), p. 201.

Capital invested in profit-seeking activities I(u) may crowd out investment in return-seeking activities I(r). Or vice versa; lack of entrepreneurship, 'low' I(u) levels may fuel real estate booms and stock bubbles. Excessive seeking of naïve profits could also depress the profits available to entrepreneurs and condemn an industry (or an economy) to Schumpeterian creative destruction cycles like those witnessed during the recent Internet bubble or the 19th century US railway expansion. Questions like the following would arise: "*How did we get to this extraordinary place where institutional allocations for venture capital far exceed the capacity of the industry despite poor recent investment results?*"[63] Just as countries differ markedly in VC investments as a share of GDP and the portion of (I) going to start-ups,[64] or just as the proportion between consumption (C) and investment (I) flows in a given economy fluctuates, I(u) levels will also vary across place and time, depict instability and often depart from alleged normative equilibrium points.

Today entrepreneurship/intrapreneurship is not part of economic growth models. Neither are investment flows leading to endogenous growth I(u) measured or treated discretely. The aim of this paper's theoretical exploration is to ponder the basis under which we could extricate I(u) from (I) in econometric models. A positive answer would lead to a taxonomy of business investment flows consistent with the main tenants of the Investment (I) Separation Theorem. Eventually the empirical testing of such models could provide new tools for policy makers in national income simulations as they work at predicting endogenous Schumpeterian innovation-based economic growth.

After experiencing annual growth averaging close to 10% from 1979 until 2010, China might be reaching the limits of its existing economic development and growth model. We have posited that the PRC's astonishing growth over the last three decades was the result of wise reforms that enabled entrepreneurs and firms to take advantage of exogenous Smithian and Solovian growth opportunities. China is already switching gears and encouraging a new type of industrialization; that is, innovation-led growth based on economic agents undertaking Knightian uncertainty. It has been pointed out that Chinese reformers in the 1980's had not

[63] Bon French, National Venture Capital Association, "Year in Review 2004-2005" (2005), pp. 13-14.

[64] OECD, Science Technology Industry - Venture Capital: Trends and Policy Recommendations, 2004, p.6. Available at: http://www.oecd.org/dataoecd/4/11/28881195.pdf

expected their success, failing to predict "the key to their own reforms" and even Deng Xiaoping admitted that the massive appearance of entrepreneurs "was not something I had thought about. Nor had the other comrades. This surprised us."[65] Today in the context of a much more advanced economy and economically savvy policy-making, foreseeing the type of economic activity that will best serve the next stage of economic transformation, that is, innovative entrepreneurship and intrapreneurship, is not the challenge. The challenge is to find the right policy mix to encourage true innovation and endogenous growth. This paper is limited to discussing the measurement step prior to such policy-making. That is, the identification of a discrete measure for endogenous growth in the investment spending aggregate of the national income accounting identity.

[65] John McMillan and Christopher Woodruff, "The Central Role of Entrepreneurs in Transition Economies", *Journal of Economic Perspectives*, Vol. 16, No. 3 (Summer 2002), p. 153.