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The Optimal Design of the Qianhai Special Economic Zone

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Abstract

Qianhai – an innovation park in Shenzhen – has the possibility of boosting innovation in Hong Kong, Shenzhen and in the wider region. This paper analyses the costs and benefits of existing plans for Qianhai and discusses the profit-maximising design of the Qianhai. We review existing evidence about which policies have promoted profitable innovation in the Qianhai region (Hong Kong and Shenzhen) in the past. We also show how a raft of legal changes concomitant with Hong Kong-Shenzhen development of Qianhai can increase innovation-led profits in the two jurisdictions. Some of these changes touch upon the mandate and organisation of the Qianhai Authority itself, and relatively poor-performing innovation agencies and schemes especially in Hong Kong. We find that such a zone would increase innovation-led profits in the logistics, IT, and other Qianhai-targeted sectors by a factor of four in the short-run and a factor of ten in the longer run. As a contribution to the wider field of innovation policy, we derive a model of the optimal innovation agency. That model shows the equilibrium and optimal levels of profits, R&D spending and cash/investment for innovative companies in a particular jurisdiction.

JEL Codes: P48, R12, R58,
Keywords: Qianhai, cross-border economic zones, innovation, special economic zones.

Disclaimer: This paper represents an attempt to use the tools of legal and economic analysis to provide interesting new insights and ideas for the establishment and development of the Qianhai Shenzhen-Hong Kong Modern Service Industry Cooperation Zone (Qianhai). We have not consulted with the Hong Kong or Shenzhen governments on this project – and nothing in this paper represents their views or tacit approval. Co-authors may not necessarily agree with all the contents of this paper and nothing in this paper necessarily reflects the views of the organisations to which the authors' affiliate. Nothing in this paper represents investment or legal advice.
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The Optimal Design of the Qianhai Special Economic Zone

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Introduction

"Qianhai" represents the first of its kind – the attempt by two special economic zones to create another (common) economic zone. The Qianhai project extends on almost 30 years of efforts aimed at promoting economic and financial integration in the Pearl River Delta – as enshrined in polices like the Closer Economic Partnership Agreement (CEPA). Policymakers on the Mainland and in Hong Kong have supported the development of the Qianhai region in south-west Shenzhen as a kind of innovation incubator. Behind the public declarations stands a vision to use the project to support R&D, innovative new companies in selected sectors like high-tech and logistics, and to attract capital as a way to bolster both cities' position as national/international financial centres.[1] How should Qianhai evolve in order to maximise profits – which in turn bolsters innovation and the capital inflows which will push Hong Kong up the international financial centre league tables?[2] What role can regulatory reform play in maximising Qianhai's impact on innovation-led profits in Hong Kong and Shenzhen?

In this paper, we find that the sub-optimal regulation of the Qianhai project/scheme will keep profits at only about 10% of their potential level. Lack of profit-oriented innovation policy will – if our model and previous studies serve as a guide – force our innovative companies to attract/retain on 3% of the total cash/investment they could otherwise attract in the long-run.[3] We also find that even in the shorter-run, R&D spending will produce far less profit – and new ideas will fail to emerge as in other locations. The structure of innovation-related markets in the Qianhai region keep profits from R&D spending and innovation to about 1/3 of their level if an activist innovation agency promoted reforms which make R&D more profitable. If policymakers – most particularly those in the Qianhai Authority – politick and campaign for governments to adopt our specific recommendations for redrafting innovation-related law, these changes could make all investors in Qianhai-related companies 30 times richer. Given serious deficiencies other scholars have found in innovation policy in the Qianhai region, such increased profits should not be hard to achieve.[4]

The optimal design of Qianhai – as our title suggests – involves adopting legal changes in several very politically sensitive and controversial areas. Lawmakers would need to privatise the Qianhai Authority (and the Hong Kong-based government structures currently failing to finance profitable

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[1] Qianhai also represents an attempt to liberalise Mainland capital markets, integrate them with Hong Kong's and encourage the repatriation of RMB. We do not discuss the capital market aspects of Qianhai, in order to focus on our main topic of supporting product/service market innovation.

[2] As we discuss in the paper, many links exist between innovation R&D, profits, investment and capital inflows into financial services markets. We thus look specifically at the relationship mentioned in this sentence – as such a relationship embodies our main question and research approach.

[3] This conclusion only applies to the innovative companies able to work in the preferential sectors targeted by Qianhai regulations. We do not claim that the entire region will only attract 3% of its potential investment.

[4] We will talk about Hong Kong and Shenzhen as the Qianhai region – mainly so we do not need to keep typing "Hong Kong and Shenzhen."

innovation at home). They would need to cancel and rewrite sections of the agreements in place supposedly governing cooperation on innovation between Shenzhen and Hong Kong (which currently mostly consist of abstract declarations of political ideals and goals). They would need to stop offering seed capital and paying for R&D directly. They would also need to allow for the incorporation of more flexible legal entities between universities and companies as well as make taking out local patents more profitable. They would need to restructure problematic programmes – like the HKU Shenzhen Institute of Research and Innovation (HKU-SIRI). Finally, they would need to allow certain parts of Hong Kong law (which most directly affect commerce) to apply in Qianhai.

We show how legal changes can impact on innovation-led profits in the region in four major steps (reflecting the structure of our paper). The first section presents the results of previous econometric and other data-focused studies of innovation and R&D in the Qianhai region. These studies provide us with costs and benefits of existing innovation law and policy as well as points to areas for reform.[5] The second section of this paper discusses proposals for redrafting specific laws that other academics and policymakers have identified as impacting on innovation in the sectors targeted by Qianhai authorities (shown in Appendix I). The third section quantifies the effects of adopting the legal changes proposed in the second section (which in turn come from the previous studies discussed in the paper's first section). We refer to a wide array of estimates of static profits, equilibrium and dynamic profits and so forth. Figure 1 may help readers unfamiliar with the jargon of the econometrics and multi-dimensional modelling we discuss. The final section of the paper provides broad conclusions. An appendix describes the Innovation Agency Theorem – which provides other agencies like the Qianhai Authority with guidance in their own unique circumstances. Our modelling work also shows the conditions under which our conclusions might be true, false and so forth. Naturally, the other appendices provide the detailed derivations, statistical analysis, and explanations needed for others to check our work and draw their own conclusions.

We must highlight several caveats before we start our main exposition. First, we do not compare Hong Kong and Shenzhen with other jurisdictions. This will disappoint readers who want to know how the optimal design could draw on "lessons" from other jurisdictions. We try to reference some of this comparative literature for interested readers in our literature review.[6] Second, we look at reform from a normative rather than positive perspective. In other words, we ignore political difficulties in implementing the reforms we suggest. If we tried to tackle these issues also, we would need another 200 pages of political economy and game theoretic models. Thirdly, our data come from a probably-non-random sample of companies. We tried to look at the issue from a range of angles, and make conclusions which do not only come from our

[5] We sometimes refer in passing to "innovation law" only as a convenient way to refer to specific provisions in various (mostly regulatory) instruments that impact on the way that companies conduct research and development (R&D), innovate and profit from such innovation.

[6] A vast literature exists showing readers how to supposedly import lessons from other jurisdictions. Block and Keller show how government agencies in the US helped foster technological innovation. Klerkx and Leeuwis describe the challenges for government agencies to encourage private agricultural enterprises to adopt innovative practices in the Netherlands. See Fred Block and Matthew Keller, State of Innovation: The U.S. Government's Role in Technology Development, 2011. See also Laurens Klerkx, and Cees Leeuwis, Establishment and embedding of innovation brokers at different innovation system levels: Insights from the Dutch agricultural sector, 76 Technological Forecasting and Social Change 6, 2009.

statistical analysis alone. Yet, readers will use their own usual good judgement when reading our work. Lastly, we must warn readers uncomfortable with economists' methods that we will be drawing heavily from a group of mathematical and statistical models to help us cut through the complexity of our question. We must rely on the most advanced econometric and mathematical techniques available because of the difficulties in picking out innovation's impact on profits (relative to other factors). Figure 1 provides an overview of common terms we use throughout the study.

Figure 1: Common Terms Used in This Study

A paper like this attracts many different types of readers. In order to ensure that all readers understand some of the specific jargon we use, we provide the following glossary. We refer to profits in the figure, but the terms may apply to any variable (like R&D, revenue and so forth).

Innovation-led profits (or profit-led innovation) – R&D spending or attempts at innovation conducted to increase company profits (or profits of a group of companies in a region).

Out-of-equilibrium profits – profits we observe on actual balance sheets. These come from the productive processes innovative companies use, and all the other chance events that make commerce what it is. We often refer to "short-run" profits in this context.

Static equilibrium profits – the level profits would settle to, after accounting for feedback effects between profits and R&D (for example) or other factors. We often refer to medium-term profits in this context, as profits usually try to settle toward to their equilibrium levels over time.

Static optimum profits – the highest values of profits innovative companies could produce (discounting random luck and market forces).

Dynamic equilibrium/optimum profits – the level(s) that profits gravitate toward over time. Dynamically optimal profits refer to the highest profit level over time (where profits in the short-term for example may even be lower so that they may be higher later).

"Controlling for" – a statistical method which removes certain effects on a variable. For example, if we show the relationship between profits and R&D "controlling for" capital expenditure (or capex for short), we use methods which sanitizes or removes the effects of capex spending on the figures we present in this paper.

Structural model/reform – refers to the model we use and its parameters. For example, we might define the structure of innovative markets as shown in mathematical appendix III. Reform would consist of activities which change the parameters of the models shown in that appendix.

Innovation law – a short-hand way of referring to the specific legal provisions (often in regulatory instruments or quasi-regulatory as in the case of Mainland Party officials' speeches and declarations) which impact on R&D process, spending, innovation and the profits obtained from such innovation.

Drafting – refers to concrete legal writing (for example the exact wording of an article in a regulation, ordinance or law).

Method of moments – an empirical method of dealing with non-linear, "complex" data which normal regression can not deal with.

What Do We Know About Finance and Innovation in the Qianhai Region?

Overview

Many of the so-called studies from the private sector paint Qianhai in glowing colours. Figure 2 shows the main conclusions reached by a number of example studies which looked at the likely effects of Qianhai on Hong Kong and Shenzhen. Most studies note that the successful development of Qianhai would ease Hong Kong's real estate constraints, help attract funds (particularly in the form of off-shore RMB that Chinese seek to repatriate) and attract a critical mass of finance, IT, and logistics companies needed to create a self-sustaining business system. Most also raise the moot question of whether Qianhai will serve to accentuate complementarities between Shenzhen and Hong Kong or exacerbate competition?[7] These self-interested publications draw on the same implicit formula. Expanding the number and size of companies working in the Hong Kong and Shenzhen region (which we call the "Qianhai region" for reasons of convenience) will automatically increase innovation and profits. Without any reference to previous studies or any convincing story, these studies just assume that expanding the availability of real estate, providing incentives for information technology (IT) companies and money (both publicly and privately given), innovation and profits will inevitably arise. None of the existing studies talk about the core role of profits. **Our paper bolsters these studies, by providing hard-core estimates of the way that Qianhai could theoretically increase innovation-led profits in the region.**

[7] While the non-academic community continues to use the rhetorical device of Hong Kong versus Shenzhen as a way of attracting attention to their publications, academics have already shown that financial and other services in the region tend to specialise – like any sector in a freely traded economy. Arner et al. (2015) provide the data and academic references for such specialisation. See Douglas Arner, David Donald, Say Hak Goo, Wei-xing Hu, Chen Lin, Bryane Michael, Frank Song, Wilson Tong, Cheng-gang Xu, Dariusz Wojcik and Simon Zhao, Assessing Hong Kong as an International Financial Centre, University of Hong Kong Faculty of Law Research Paper No. 2014/012, 2014, available online.

Figure 2: Self-Interested Parties Writing About a Glorious Qianhai and their Formulae for Success

What advantages would the creation of Qianhai generate for Hong Kong and Shenzhen? Would profit-led innovation exceed the destructive influence of financial market and industrial competition? Most of the analyses boil down to the simple formula shown below. Qianhai could serve as nothing more than a glorified real estate development. Yet, with full participation by the Hong Kong and Shenzhen governments, Qianhai could represent the first special economic zone created by/from two special economic zones – with real twin cities' benefits. Yet, these studies do not talk about Qianhai's real *raison d'etre* – how the region will promote profitable innovation.

Value of Qianhai innovation = financial easing + tech company attraction + access to big market - costs from financial market and industrial competition

Author (and link)	Major theses
Colliers *	Qianhai will promote innovation by relaxing space (real estate) constraints and easing the flow of money (RMB) to companies.
Credit Suisse *	Qianhai represents a platform for internationalising the RMB and Hong Hong's high-tech service offerings into the Mainland.
Daiwa *	Logistics plus finance and incentives to bring financial, technological, logistics and telecoms make for a unique geographical place of profit.
Cushman Wakefield *	Qianhai represents a land extension for Hong Kong (as little geographical room to grow).

Source: See individual sources for more information.

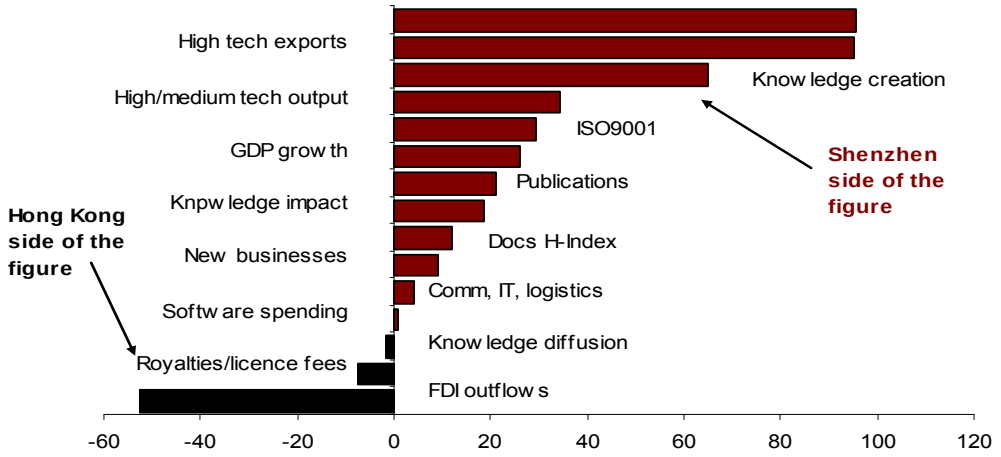
The data falsely appear to confirm the common sense intuition that Shenzhen would supply the property rights (the brains) and Hong Kong would supply funding (or the financial brawn) to a joint Qianhai undertaking. Figure 3 shows the scores from the Global Innovation Index for 2015 for Shenzhen (which we calculated using regression analysis by using national China-level scores) and for Hong Kong.[8] As shown, Shenzhen scores much higher in most of the "knowledge and technology outputs" (part 6) components of the dataset.[9] Hong Kong appears to diffuse – rather than create – knowledge as well as provide a vector for collecting licensing and royalty fees and for sending money out of the China region. **Given Hong Kong's rank – of 29th place ranking out of 56 countries on the recent Global Innovation Index -- Hong Kong needs to cooperate with Shenzhen on Qianhai in order compete with other jurisdictions like the US or Finland.**[10]

[8] As explained in the figure, we treated Shenzhen as a separate jurisdiction, looking at correlations between similar jurisdictions and Shenzhen. With these differences in mind, we could adjust the China-level national scores up or down to reflect our regression outcomes. In practice, such a complicated technique turned out useless – as Shenzhen's scores differed in only a few areas.

[9] See Rafael Escalona Reynoso and Jordan Litner. (2015). The Global Innovation Index 2015: Effective Innovation Policies for Development, 2015, available online.

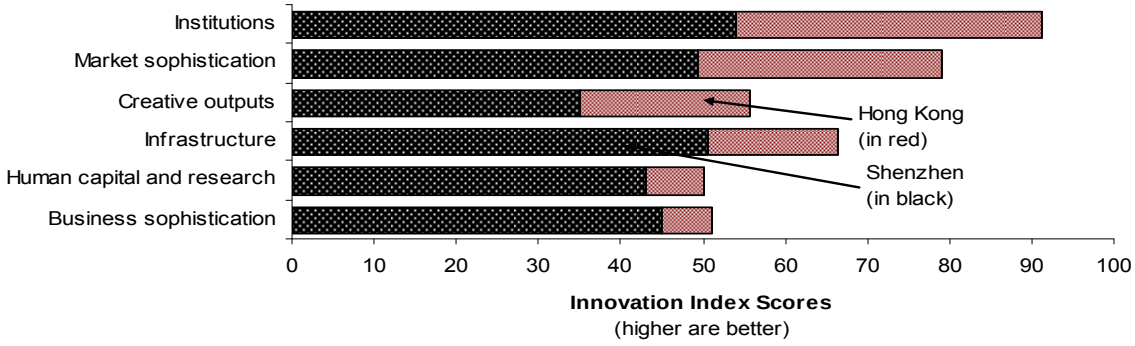
[10] The Index uses the usual quantitative indicators of innovation policy – like patents, journal citations, spending per capita on R&D and so forth. Ezell provides more on these indicators. See Stephen Ezell, Adams Nager and Robert Atkinson, Contributors and Detractors: Ranking Countries' Impact on Global Innovation, Information Technology and Innovation Foundation, 2016, available online.

Figure 3: Showing that Shenzhen Provides the Brains and Hong Kong the Financial Brawn



The figure show s the Global Innovation Index for Shenzhen and Hong Kong in 2015. We use China's data as a base for calculating Shenzhen's Innovation sub-indices. We adjust Mainland innovation scores, as the dependent variable, from a regression w hich regresses Shenzhen's GDP per capita and its proportion of GDP in industry w ith the innovation scores held by other countries w ith similar levels of these GDP per capitas and industrialisation. In practice, w e only needed to modify tw o variables (know lege creation and know ledge impact).
Source: Escalona and Litner (2015).

Figure 4: Yet Hong Kong Beats Shenzhen in the Factors that Make for Profitable Commerce



The figure show s the Global Innovation Scores for China (as a proxy for Shenzhen) and Hong Kong. We do not adjust China's scores to take into account Shenzhen's particularities - as don't w ant to confuse the reader by presenting data w hich have been highly modified. We also might argue that national policy determines most of these factors -- thus Shenzhen might show little meaningful difference w ith the broader Mainland. Hong Kong can clearly provide the market-oriented institutions, market sophistication, infrastructure, human capital and business sophisication needed to make Qianhai a success. Source: based on data from Escalona and Litner (2015).

Literature Review

Yet, behind the self-serving analysis of companies looking to cash in on Qianhai, what do we already know from the academic literature about the way a Qianhai-style development might promote innovation-led profits?[11] Figure 5 shows the clusters of research which directly or indirectly answer the question – **what effect would Qianhai have on Hong Kong's innovation-led profits?** The first group of studies looks at the Closer Economic Partnership Agreement (CEPA) and other related agreements which we review in the legal analysis section of this paper. Unsurprisingly, academics consider the largest positive benefits stemming from the usual gains from trade. Scholars have not specifically addressed the extent to which relaxing capital constraints and industrial policies (specifically choosing sectors rather than having market forces decide them) has contributed to this growth.[12]

Figure 5: Literature of Relevance for the Qianhai Design Question

Summary and major authors	Description and Results
CEPA (and special/border economic zone literature more generally) Chen & Unterober-doerster (2008), Shen (2014), Shen and Luo (2013), Hsiao (2012)	**Question:** Based on previous experience with economic integration in the Guangdong region, would Qianhai actually generate benefits above/beyond the status quo? **Result:** Several poorly done studies show that regional integration has generated benefits so far. Yet, Hong Kong's institutions and rule of law explain any profit-generating innovation better than simple economic integration. Thus, if Qianhai can share some of Hong Kong's institutions, the project would be much more successful.
Innovation Systems literature Baark and Sharif (2006), Xu *et al.* (2010), Fu (2011), Fu & Li (2011), Li *et al.* (2006).	**Question:** What does it take to make an innovative area (cluster)? What parts of a Qianhai-law would lead to innovation-led profits (and thus demand for Hong Kong's financial services)?[13] **Result:** Institutions represent a key constituent for growth. Given the tension between Hong Kong's Anglo-Saxon "variety of capitalism" and Shenzhen's "Continental variety of capitalism," any Qianhai-law holds little promise of working in the medium-term. Moreover, forced growth (rather than organic growth) makes firms locating in Qianhai less likely to survive/thrive.

[11] We refer to the phrase "innovation-led profits" frequently in the text – to refer to profits that more and bigger companies could make from innovations which would not occur without agglomerating Hong Kong and Shenzhen. Any economic approach to innovation must accept to measure innovation as the probability-adjusted (weighted) long-term expected profit from companies engaged in creating new tech-related goods and services. We provide relevant references to the literature in our modelling appendix.

[12] Chen and Unteroberdoerster provide one of the most relevant studies for our purposes. They have mapped the economic clusters developing in and around the Hong Kong/Shenzen area. See Hong-yi Chen and Olaf Unteroberdoerster, Hong Kong SAR Economic Integration with the Pearl River Delta, IMF Working Paper 08/273, 2008, available online. See also Jian-Fa Shen, Not quite a twin city: Cross-boundary integration in Hong Kong and Shenzhen, 42 Habitat Int'l, 2014, available online. See also Jian-fa Shen and Xiao-long Luo, Relationship between Hong Kong and Mainland China in Transition: From Fortress Hong Kong to Hong Kong–Shenzhen Metropolis: the emergence of government-led strategy for regional integration in Hong Kong. 22 J. of Contemp. China 84, 2013.

[13] Of course, talking about "Qianhai law" makes little sense (as the region has little if any administrative autonomy). We use this phrase as short-hand to talk about the relevant legal provisions affecting Qianhai's operation.

Finance of Innovation literature Cheung *et al.* (2015), Sharif and Huang (2010), Baark *et al.* (2011).	**Question:** Will more govt-led finance in Hong Kong and Shenzhen actually result in innovation-led profits far in excess of the status quo? **Result:** Scholars can not agree. But complementarities between the two jurisdictions likely lead to conflict rather than cooperation
Investment flow literature Girma et al. (2009), Wang & Wang (2010), Zhang (2011).	**Question:** How to encourage investors in the Qianhai region and outside to invest in Qianhai-based companies? **Result:** Such a push probably mis-guided. Capital needs to go to highest productive use. Encouraging capital to go to Qianhai without existing great ideas distorts capital, labour and goods/services markets.

Source: See cited authors for more information on these sources.

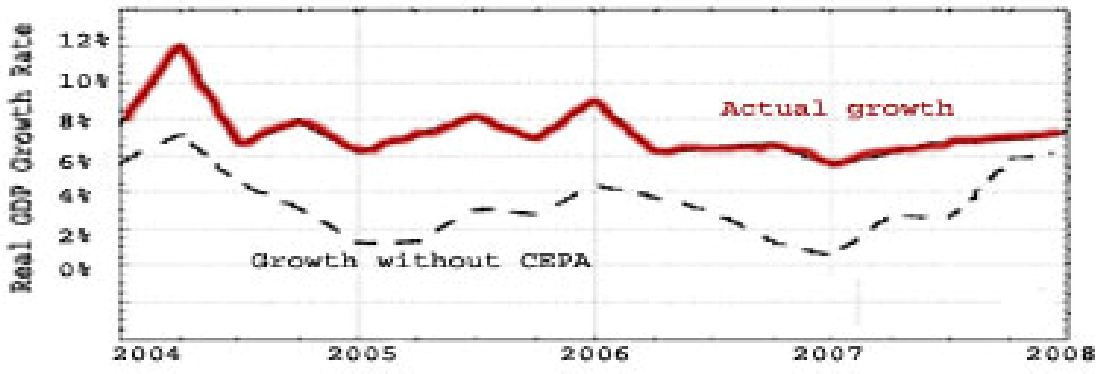
Several studies from this first group of studies claim to show how closer union between Hong Kong, Shenzhen (and the Guangdong region in general) helps promote at least growth – if not innovation. Figure 6 shows that the Closer Economic Partnership Agreement (CEPA) supposedly has helped keep Hong Kong's GDP up during – what would otherwise be – major slowdowns in GDP growth.[14] According to this study, the CEPA contributed around 3%-4% in GDP growth over the period the authors looked at. The figure also shows the purported effect of regional integration on generalized productivity (what economists call "total factor productivity"). CEPA supposedly has increased such productivity. Naturally, increases in productivity necessarily frequently imply change in industrial innovation – as innovation makes production better, cheaper and so forth. Thus, the authors' results for productivity might serve as a proxy for CEPA's effect on innovation.[15] Figure 7, for its part, shows similar results – with the authors hypothesizing that Hong Kong could benefit from a "Guangdong effect" – which helps promote trade, innovation and productivity.[16] As Hong Kong's manufacturing sector shrinks, Hong Kong's manufacturers reduce duplication/ competition with Shenzhen and Guangzhou. Such shrinkage also helps resources move to more productive sectors. **Yet, most studies of regional integration are so badly done that they provide a flimsy base from which to draw conclusions about Qianhai.**

[14] See Cheng Hsiao, Steve Ching and Ki-Wan Shui, A Panel Data Approach for Program Evaluation: Measuring the Benefits of Political and Economic Integration of Hong Kong with Mainland China, 27 Journal Of Applied Econometrics 1, 2012, available online.

[15] Xu and Yu find, using a completely different methodology that Shenzhen's total factor productivity grew by around 5% per year. See Yan Xu and Shu Yu, Total Factor Productivity among Cities in China: Estimation and Explanation, Conference Board Economics Program Working Paper 12 – 01, 2012, available online.

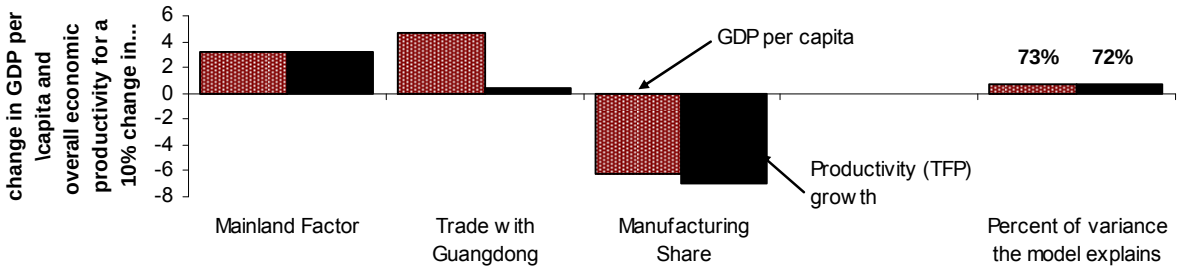
[16] See Jun-sen Zhang, Harry Wu, Wing-Sung Yun, Shao-jin Zhou and Ning Zhang, A Further Study on the Future Development of the Hong Kong Economy, Consolidation and Enhancement of Existing Core Industries and Development of Economic Areas with High Potential in Hong Kong, 2009, monograph for Hong Kong's Central Policy Unit, available online.

Figure 6: A Casino Study Says that Hong Kong's Regional Integration Might Have Added an Extra 4% to GDP Growth



The figure shows changes in Hong Kong's real GDP growth for the period shown -- if the authors' Monte Carlo studies reflect reality. The authors' methodology consisted of using other countries' data as a baseline and then simulating results for the Hong Kong economy.
Source: Hsiao et al. (2012).

Figure 7: A Very Misspecified Econometric Study Finds Evidence of a "Guangdong Effect"



The figure shows the coefficients for regressions trying to explain Hong Kong's GDP per capita growth rate and general productivity (what economists call "total factor productivity" or TFP). The figure shows trade with the Mainland, trade with Guangdong, and manufacturing's share of Hong Kong's GDP as explanatory variables. We also show the misleading percent of variation the model explains (known to economists as the model's R-squared). The model's results are useless, as the authors failed to control for other factors which affect GDP growth (like labour used), they don't take into account that GDP growth affects trade as much as trade affects GDP growth (called "endogeneity bias") and other problems.
Source: Zhang et al. (2009).

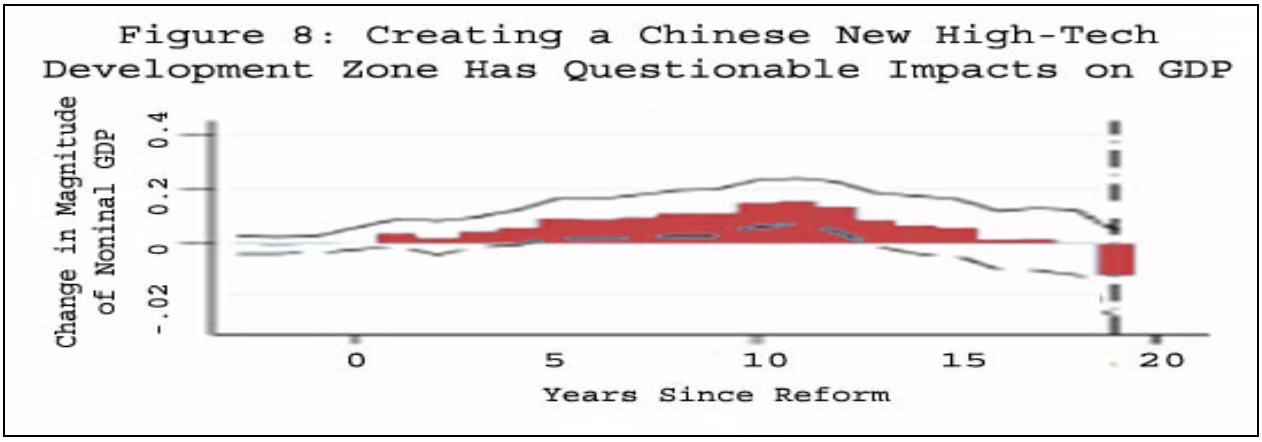
We really do not know what effect regional integration had on innovation in Hong Kong.[17] The Hsiao *et al*. study created a model based on numerous other economies in order to simulate what benefits might have accrued to Hong Kong. Based on these findings, they ran simulations – known as Monte Carlo (like the casino Mecca) simulations – to see what the benefits might have been if we compared our reality with hundreds of other realities. The Zhang study makes firm predictions about integration in the Pearl River Delta region by taking the results of a simple regression of GDP growth and total factor productivity on levels of integration (trade). Their specification suffers from problems with economists know as "endogeneity bias", "omitted

[17] The internet and journals are flooded with badly done quantitative studies looking at the effect of innovation on Chinese firm profitability. We do not have room to provide a full list. For one example, Zhao-hui Zhu and Feng Huang, The Effect of R&D Investment on Firms' Financial Performance: Evidence from the Chinese Listed IT Firms, *Modern Economy 3*, 2012, available online.

variable bias" and other misspecification error.[18] As a more substantive critique, authors like Shen and Luo (2013) have found that political gains, more than economic gains, drove much of Hong Kong's increased co-operation on integration with Shenzhen.[19]

The establishment of special economic zones in the Qianhai region might account for these results far more than any gains from regional integration. Figure 8 shows the estimated effect of creating a high-tech industrial zone – like the proposed Qianhai zone – based on past experience.[20] Accordingly, the establishment of Shenzhen-region high tech zones (more than economic and trade integration with Hong Kong) explain growth in the region. Other authors have shown how such zones – and especially the transport links that tie these zones together - result in productivity growth.[21] These zones benefitted because they were already industrialized areas.[22] If Jin and co-authors' findings reflect Qianhai's future, creating a special economic zone *ex nihilo* will have very limited impacts on innovation. Yet, authors like Sawyer and colleagues might argue that these gains came mostly from the resource accumulation due to the central government's orders – and not from the natural attraction of resources according to Shenzhen's comparative advantage.[23] **Because we can not separate the innovation-creation effects from the innovation-diversion effects in these studies, we can know the extent to which Qianhai would create innovation unavailable otherwise**.[24]

[18] We do not have space to explain what these terms mean. For non-technical readers, they/you only need to know that the problems with the study mean that the results tell us nothing about integration in the region.
[19] See also Jian-fa Shen and Xiao-long Luo, Relationship between Hong Kong and Mainland China in Transition: From Fortress Hong Kong to Hong Kong–Shenzhen Metropolis: the emergence of government-led strategy for regional integration in Hong Kong, 22 Journal of Contemporary China 84, 2013, available online.
[20] See Simon Alder, Lin Shao, and Fabrizio Zilibotti, Economic Reforms and Industrial Policy in a Panel of Chinese Cities, 2015, available online.
[21] See Ying Jin, Mr. Richard Bullock, and Wanli Fang, Regional Impacts of High Speed Rail in China: Spatial proximity and productivity in an emerging economy: econometric findings from Guangdong Province, People's Republic of China, Working Paper 2, 2013, available online.
[22] Barbieri and Pollio find – in an analysis of Guangdong special economic "enclaves" – that highly industrialised areas benefit the most from these zones. See Elisa Barbieri and Chiara Pollio, Industrial Development and manufacturing in Chinese territories: the contribution of special economic enclaves policies, Interuniversity Centre of Applied Economics Working Paper 1/2015, 2015, available online.
[23] See Charles Sawyer, Kiril Tochkov and Wen-ting Regional and sectoral patterns and determinants of comparative advantage in China, Yu, Texas Christian University Department of Economics Working Paper Series Working Paper Nr. 15-02, 2015, available online.
[24] Zheng and colleagues use geographical data for the location of various industrial parks to look at which factors contribute to productivity growth in these parks. For the general sample – we can not separate out Shenzhen's effects – they find that from productivity growth (or total factor productivity) comes denser output and input linkages, skill spillovers, and access to rail travel. Yet, broader industry change also plays a role. See Siqi Zheng, Wei-zeng Sun, Jian-feng Wu, and Matthew Kahn, The Birth of Edge Cities in China: Measuring the Spillover Effects of Industrial Parks, 2015, available online.



As in other parts of economics, numerous authors are finding that institutions play a larger role in innovation than simple trade creation/expansion. A recent Asian Development Bank study focused on cross-border economic zones (like the proposed Qianhai scheme).[25] The authors found that these cross-borders zones need their own special, unique policies in order to attract companies and related investment in the zone. Using relative simple statistical methods, these authors find that – contrary to the case in Shenzhen-Hong Kong region – these cross-border zones *raison d'etre* revolves around importing resources and lowering production costs.[26] Qianhai neither helps import resources nor lower production costs significantly. Thus, **governments on both sides of Qianhai's cross-border economic zone should harmonize infrastructure, labour policies, and other market institutions so as not to create a divided city/region.**

The second branch of the literature (which we summarised about in Figure 5) focuses on the way that "innovation systems" have developed in the Qianhai region – and how they might interact. Such innovation system studies look at the way cooperation and competition between manufacturing/IT and service firms leads to profitable innovation.[27] Figure 9 shows the constellation of innovation relationships around the Shenzhen region.[28] Accordingly, Shenzhen's innovation system revolves around university-company collaboration – with a wide range of one-to-one (called dyadic) connections. **Thus, universities should serve as central actors in promoting innovation in the Qianhai region.**

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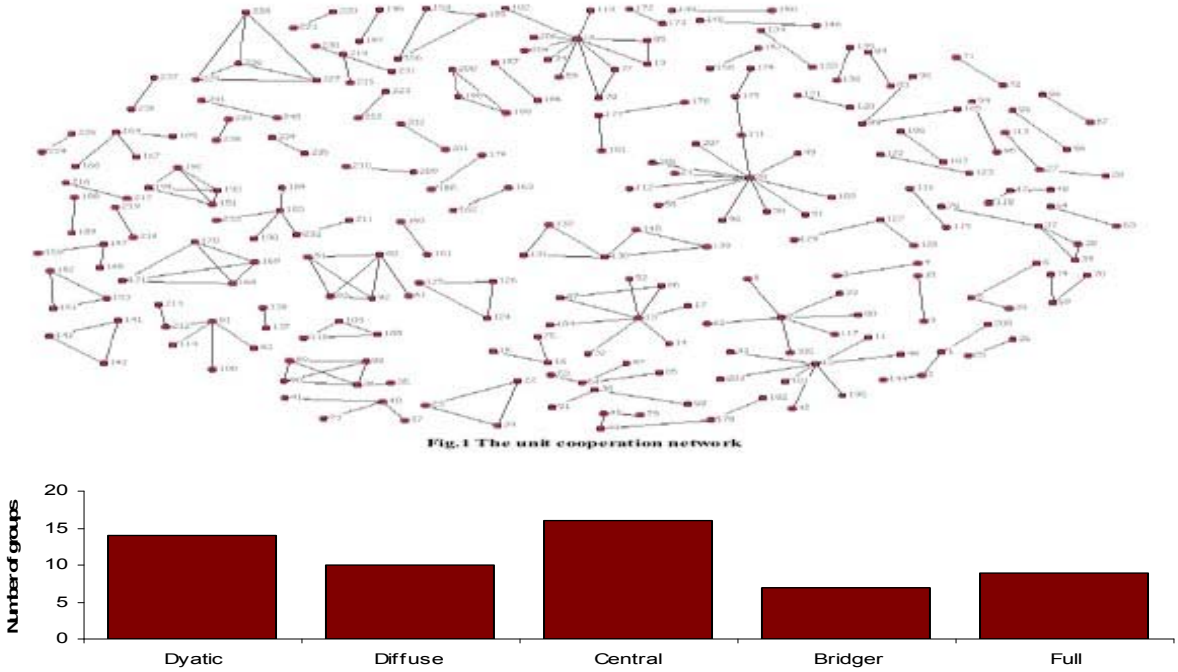
[25] See Xian-ming Yang, Zan-xin Wang, Ying Chen, and Fan Yuan, Factors Affecting Firm-Level Investment and Performance in Border Economic Zones and Implications for Developing Cross-Border Economic Zones between the People's Republic of China and its Neighboring GMS Countries, *1 Greater Mekong Subregion–Phnom Penh Plan for Development Management Research Report Series 1*, 2011, available online.

[26] One might view innovative ideas or even errant RMB as a type of resource. Yet, the study most specifically focused on materials and raw materials.

[27] Several scholars have studied Hong Kong's innovation system – and such systems in the region overall. Baark and Sharif provide the historical background of Hong Kong's innovation system. Boeing and Sandner describe the innovation system from the China side. See Erik Baark and Naubahar Sharif, Hong Kong's innovation system in transition: challenges of regional integration and promotion of high-technology, In Bengt-Ake Lundvall, Patarapong Intarakumnerd and Jan Vang (Eds), Asia's Innovation Systems in Transition: New Horizons in the Economics of Innovation series, 2006, available online. See also Philipp Boeing and Philipp Sandner, The Innovative Performance of China's National Innovation System, Frankfurt School Working Paper Series 158, 2011, available online.

[28] We focus on these relationships in Shenzhen as the Qianhai project physically sits in Shenzhen. See Hui Xu, Su-sheng Wang and Zhi-chao Li, Research on Shenzhen University-Industry Cooperation Based on Patent Data Analysis, 2010 International Conference on Management Science & Engineering, 2010.

Figure 9: The Shenzhen University-Industrial Innovation Network Highly Fragmented



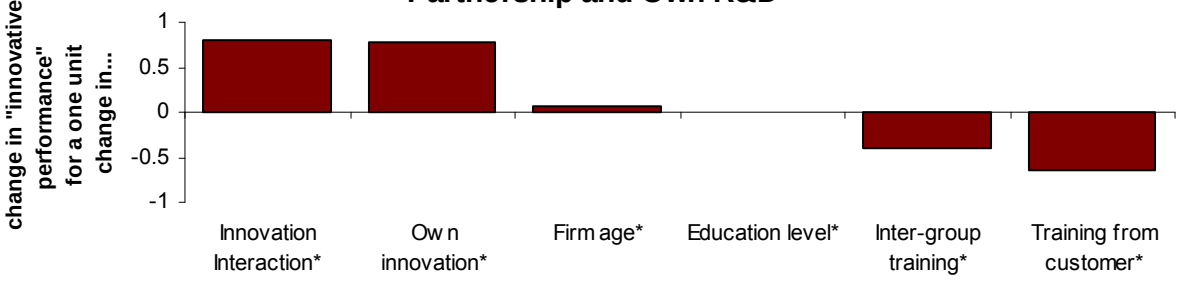
The figure shows the number of groups (clusters) formed when a Shenzhen-based university applies for patents with local companies. The roughly 240 institutions form highly fragmented relationships with each other (as shown by the large number of "sticks" and few "spider webs"). The bottom part of the figure shows the frequency of each type of group – from most sparse to most lush. Source: Xu *et al.* (2010).

What affects the rate at which these network relationships generate innovations? Figure 10 represents one example of a study seeking to answer that question.[29] Innovative interaction and firms' own innovation count much more for innovation than training, education, firm experience and other factors. The authors importantly find that ownership structure and even innovation supposedly "imported" from abroad have no positive effects on the "innovative performance" of Shenzhen-based firms.[30] Yet, not all innovation (or R&D resulting in that innovation) is the same. Gau *et al.* (2015) find that when innovative firms list on an exchange, they engage in "exploitative" rather than "exploratory" R&D.[31] To the extent that Chinese firms engage in R&D, new product development accounts for roughly 13% of such R&D expenditure.[32] Lau and colleagues found that Hong Kong based manufacturers innovate more with supplier-customer

[29] See Wenying Fu, How is Innovation fostered under different Institutional Setup: Comparing the Electronics Cluster in Shenzhen and Dongguan, China, European Regional Science Association Conference Paper ERSA11P736, 2011, available online.
[30] See original study for definitions of "innovative performance" and the other factors in the study.
[31] Hua-sheng Gao, Po-Hsuan Hsu, and Kai Li, Public Market Listing and Corporate Innovation Strategies: Evidence from Private Firms, 2015, available online.
[32] Gary Jefferson, Hua-mao Bai, Xiao-jing Guan, and Xiaoyun Yu, R&D Performance in Chinese industry, 15 Economics of Innovation and New Technology 4-5, 2006, available online.

integration, when they co-develop new innovative products, and when they share information with others in the business system (suppliers, customers, etc.).[33]

Figure 10: Shenzhen Innovation System Centres Around University-Company Partnership and Own R&D



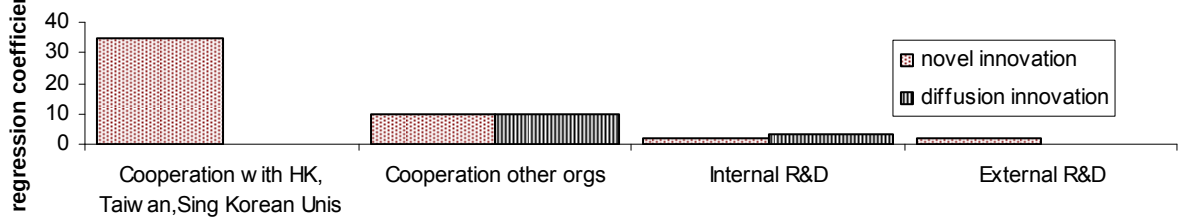
The figure shows the results of surveys, of 167 Shenzhen electronics firms, asking about the importance of various methods for producing electronics-related innovations. These results represent the b-value coefficients for a logit regression. In other words, a ten unit increase in a Shenzhen electronics firms own innovation results in 8 units of "innovative performance" (whatever that is). Intergroup training and training from the customer result in harms rather than beenfits. In Shenzhen, unlike in other Chinese cities, the ownership structure, firm size, extent of foreign-led innovation, training from a multinational's headquarters and training done via Guanxi relations have no statistically significant effect on innovative performance. Source: Fu (2011).

Yet, simply enlarging the scale of such cooperation does not ensure the broader development of profit-generating innovation. Ben and Wang find that industrial parks which are too large also result in just as inefficient production (and thus have the same lower productivity) as parks which are too small.[34] Qianhai represents one of the largest industrial parks proposed to date. Even if local officials could grow a very large industrial park area, they have no guarantee that firms based there could profitably absorb and use innovative ideas.[35] Authors like Yasar find a strong positive statistical relationship for Chinese firms in general between outside investment and firms' "absorptive capacity."[36] As shown in Figure 11, collaboration with universities represents one way of developing such absorptive capacity. Chinese firms that made alliances with Hong Kong-based (and other) universities innovated more.[37] Alliances with local Mainland universities brought no such significant innovation. These data suggest that Qianhai companies would benefit more from their access to Hong Kong's universities than from the zone per se. **A Qianhai**

[33] See Antonio Lau, Esther Tang and Richard Yam, Effects of Supplier and Customer Integration on Product Innovation and Performance: Empirical Evidence in Hong Kong Manufacturers, 27 Journal of Product Innovation Management 5, 2010.
[34] Tai-Ming Ben and Kuan-Fei Wang, Interaction Analysis among Industrial Parks, Innovation Input, and Urban Production Efficiency, 7 Asian Social Science 5, 2011, available online.
[35] See Philipp Boeing, Elisabeth Mueller and Philipp Sandner, What Makes Chinese Firms Productive? Learning from Indigenous and Foreign Sources of Knowledge, Frankfurt School – Working Paper Series 196, available online.
[36] Yasar uses the employment of knowledge workers like engineers, technicians and managers – as well as firm size -- as a gauge of these firms' absorptive capacity. See Mahmut Yasar, Imported Capital Input, Absorptive Capacity, and Firm Performance: Evidence From Firm-Level Data, 5 Economic Inquiry 1, 2013, available online.
[37] Huang and company find similar results with techno-parks in and around Beijing. Local government support proved un-useful – but links with Hong Kong helped foment innovation. See Can Huang, Yilin Wu, Pierre Mohnen, and Yan-yun Zhao, Government Support, Innovation and Productivity in the Haidian (Beijing) District, United Nations University Working Paper #2013-058, 2013, available online.

without significant Hong Kong participation would just remain another property development project.

Figure 11: Qianhai's Destiny Likely Tied to Cooperation with Hong Kong's Universities



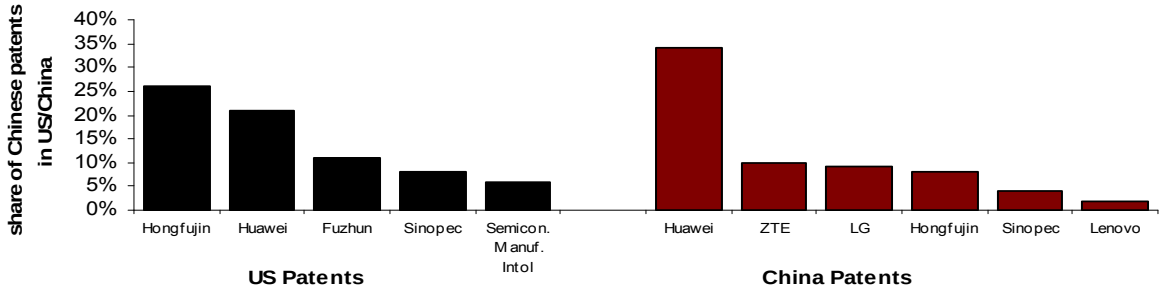
The figure shows the parameter estimates for Tobit regressions on the extent of novel innovation (as sales of newly conceived products) and diffusion innovation (sales of improved versions of products already on the market). Cooperation with Newly Industrial Economies (NIEs) -- which we take in this context as Hong Kong, Taiwan, Singapore and Korea (due to similar use in other papers in this literature) -- varies strongly and closely with such innovation. Source: Fu and Li (2011).

Numerous studies support the finding that the overall policy environment – rather than targeted sectoral innovation policies – explain much of the performance of innovation systems in these special economic zones. Bhattacharya *et al.* (2015) for example, find that stability in the policy environment is more important than the type of innovation policy pursued.[38] Du and co-authors find that institutions providing for contract enforcement and IP protection explain why foreign investors choose one province or city over others.[39] Yueh, for her part, shows how the protection of property rights (through patent law) explains much of the variation in output-generating innovation across Chinese regions.[40] Eberhardt and co-authors find that a limited number of companies account for most of China's patents.[41] As shown in Figure 12, we see that large industrial giants file for most Chinese patents. The authors don't explicit say it – but Chinese companies seemed to take out US patents when trying to protect a more commercially profitable product or process invention.[42] Cumming *et al.*, for their part, show that legality affects IPO or private exits much more than factors like stock market capitalization, market conditions, the skill of the VC fund manager, fund characteristics, as well as firm and transaction attributes.[43] Li and colleagues find, in their own statistical study of Shenzhen, that poorly defended IP rights in

[38] See Utpal Bhattacharya, Po-Hsuan Hsu, Xuan Tian and Yan Xu, What Affects Innovation More: Policy or Policy Uncertainty? Kelley School of Business Research Paper No. 2014-48, 2015, available online.
[39] See Julan Du, Yi Lu, Zhi-gang Tao, Economic institutions and FDI location choice: Evidence from US multinationals in China, 36 Journal of Comparative Economics 3, 2008, available online.
[40] See Linda Yueh, The Determinants of Innovation: Patent Laws, Foreign Direct Investment and Economic Growth in China, available online.
[41] See Markus Eberhardt, Christian Helmers, and Zihong Yu, Is the Dragon Learning to Fly? An Analysis of the Chinese Patent Explosion. Centre for the Study of African Economies Working Paper WPS/2011-15, 2011, available online.
[42] This argument relies on the interpretation of the authors' results concerning SIPO (Chinese) and USPTO (USA) patents. They show how Chinese IT companies which had been particularly worried about their intellectual property, would take out a USPTO patent rather than – or in addition to – a SIPO patent.
[43] See Douglas Cumming, Grant Fleming, and Armin Schwienbacher, Legality and venture capital exits, 12 Journal of Corporate Finance 2, 2006, available online.

Shenzhen stifles industrial innovation.[44] **Studies like these tend to show that the institutional environment in Qianhai will matter far more than any tax rebates or even capital account liberalisation rules Qianhai adopts.**

Figure 12: Innovation in China Relies More on Membership in Financial Industrial Group and Applicable Law More Important than Geographic Proximity



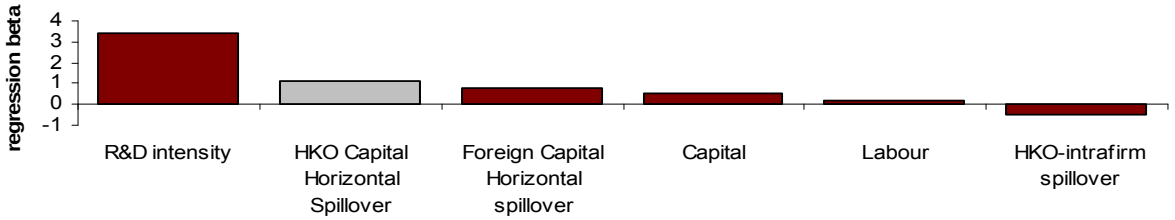
The figure shows the proportion of total Chinese patents received by the companies shown. For example, Hongfujin filed for roughly 25% of all US patents during the time period covered by the authors. The high proportion of patents going to China's industrial giants casts doubts on the ability of a Qianhai to grow a mass of entrepreneurial companies which will dominate patent filings in the future.
Source: Eberhardt *et al*. (2011).

The third branch of the literature – which we outlined in Figure 5 above -- deals with the effect of finance on innovation. More spending in the Qianhai region – either by government or industry – as this argument goes, can help generate the innovation needed to boost profitability, and thus investment in Hong Kong and Shenzhen. Writers like Cheung et *al.* (2015) and Naubahar and Baark (2005) for example erroneously argue that Hong Kong's R&D spending needs to rise in order to facilitate the development of innovative companies.[45] The Commission on Strategic Development's (of Hong Kong) analysis comes to much the same conclusion.[46] Zhang represents another "dim sum" style analysis – offering a wide range of potential policies – with scant empirical support.[47] **Given Shenzhen's vast lead over Hong Kong in many areas of innovation policy, any policy aimed at looking at Hong Kong (or Shenzhen) in isolation is misguided.**

[44] Ping Li, Rong Li and Yan-gao Xiao and Xiao-hong Cai, Empirical Research on the Competence of Intellectual Property Rights in Shenzhen Based on Regional Industrial Innovation, 4 Journal of Electronic Science and Technology of China 4, 2006, available online.
[45] See Edwin Cheung, Rita Lun and Lap-chee Tsui, The Ecosystem of Innovation and Technology in Hong Kong, Our Hong Kong Foundation Working Paper, 2015, available online. See also Naubahar Sharif and Erik Baark, The Tamest of Tigers? Understanding Hong Kong's Innovation System and Innovation Policies, available online.
[46] Their analysis represents a hodgepodge of *ad hoc* solutions covering a wide range of policy areas. Presumably the approach they adopt consists of trying everything and see what works. See Commission on Strategic Development, Promotion of Innovation and Technology Development in Hong Kong, 2015, available online.
[47] See Jun-sen Zhang, Harry Wu, Yun Wing Sung, Shaojin Zhou and Ning Zhang, A Further Study on the Future Development of the Hong Kong Economy, Consolidation and Enhancement of Existing Core Industries and Development of Economic Areas with High Potential in Hong Kong, 2009, monograph for Hong Kong's Central Policy Unit, available online.

The evidence on government support for innovation in Hong Kong and Shenzhen provides no clear cut answers. From international studies, authors like Brander and colleagues, show that government funded venture capital augments—rather than replaces – private finance.[48] When government and private start-up investors participate together, the resulting firms are more successful and more likely to list on publicly-traded equities markets. In the Hong Kong context, Sharif and Huang show that ventures on the Mainland tend to survive longer and do better when Hong Kong companies invest in their R&D more heavily.[49] As further shown by these two researchers, shown in Figure 14, Huang and Sharif show that R&D investment represents a far more useful vector of innovation than money from Hong Kong (or abroad).[50] These results cast doubts over the "division of labour" between Shenzhen (strong in production and innovation) and Hong Kong (strong on finance). Worse still, **these results would suggest that the Qianhai project represents a zero-sum game – where Shenzhen's gain could be Hong Kong's loss.**[51]

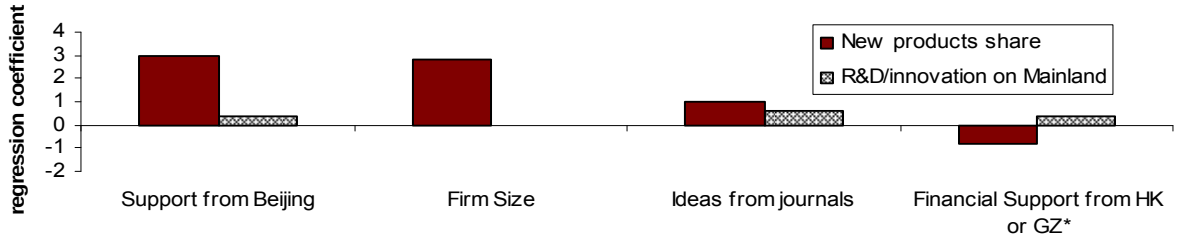
Figure 13: R&D intensity far more important than Hong Kong Sourced Investment as Source of Industrial Growth



The figure shows the regression coefficients for innovation growth (with industrial value added as the dependent variable). The original paper looked at capital from Hong Kong, Taiwan and Macau -- which we can not disaggregate into Hong Kong only. We thus label the effect of this capital as from Hong Kong and Other (with Macau and Taiwan representing the other). We show only one model's results out of many (the most relevant model in our opinion). See the original for more details. Source: Huang and Sharif (2009).

[48] See James Brander, Qianqian Du and Thomas Hellmann, The Effects of Government-Sponsored Venture Capital: International Evidence, 19 Review of Finance 2, 2015.
[49] Naubahar Sharif and Can Huang, Innovation strategy, firm survival and relocation: The case of Hong Kong owned manufacturing in Guangdon province, China, UNU Merit Working Paper Series #2010-052, 2010, available online.
[50] Can Huang and Naubahar Sharif, Manufacturing dynamics and spillovers: The case of Guangdong Province and Hong Kong, Macau, and Taiwan (HKMT), Research Policy 38, 2009.
[51] Such an outcome depends on income and substitution effects of R&D spending. A zero-sum game ensues if R&D funders must choose between Hong Kong and Shenzhen. If R&D spending expands profits in the longer run, then total R&D spending could rise in both places. We know of no study looking at the effect of R&D spending to generate further R&D spending.

Figure 14: Does Hong Kong and Shenzhen Government Financial Aid for Innovation Actually Hurt Innovation?



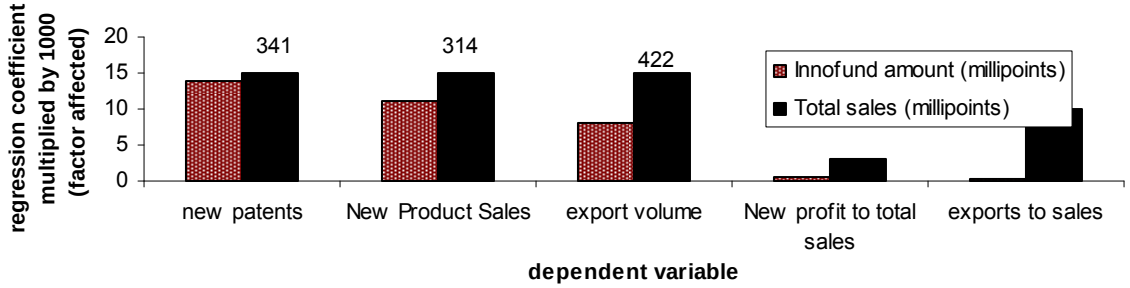
The figure shows the extent to which various factors explain a firm's share of a new products market and R&D/innovation on the Mainland. For example, firms with support from the central government in Beijing tend to capture a greater share of it's new products market-niche. The effect of financial support from local governments in the Guangzhou region (Hong Kong and Shenzhen) remains much less clear. The authors show one model where the effect of such support hurts innovation -- and one which helps innovation.
Source: Sharif and Huang (2012).

Several authors have highlighted the futility of government spending as a way of promoting innovation in the Qianhai region. Guo and co-authors (2014) find that only government funding from the central government would have a positive effect on firms in the Qianhai region. Financing for innovation from Hong Kong actually correlates with the loss of market share (albeit with increased R&D spending).[52] Yet, as shown in figure 15, work by Guo and colleagues raise doubts about even the central government's ability to spend their way into innovation. They find that government support only microscopically helps regional firms improve profits and patent production. More worrying, Baark and co-authors (2011) find that such product market shares do not even depend on the typical factors often associated with innovation policy – like more machines, R&D capacity or cooperation with universities in the Qianhai region and abroad.[53] As shown in Figure 16, internal departments' activity seems far more important for product market share than these other factors. **If true, these kind of results cast doubt both on Hong Kong's ability to use finance to promote innovation at home and in the overall Qianhai region.**

[52] Our interpretation of this study contradicts the authors' own interpretation of their results. They argue that their finding support the view that Innofund finance improved innovation-related outcomes. We argue not always (as highlighted in the main text). We leave it to the reader with a doctoral background in economics to decide which interpretation is right, given the results reported in the paper's many figures. See Di Guo, Yan Guo, and Kun Jiang, Government Subsidized R&D, Project Screening, and Firms' Innovation: Evidence from China, 2014, available online.

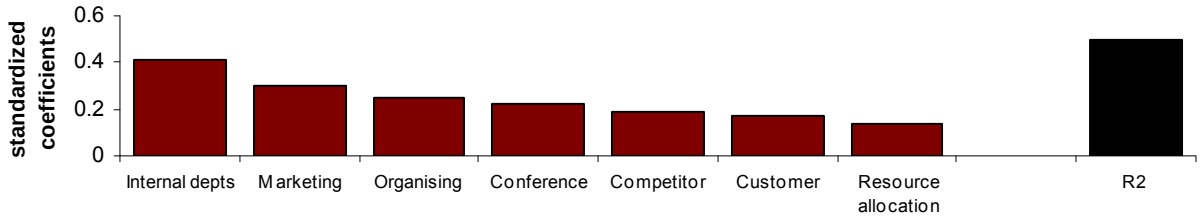
[53] Erik Baark, Antonio Lau , William Lo, and Naubahar Sharif, Innovation Sources, Capabilities and Competitiveness: Evidence from Hong Kong Firms, DIME Final Conference, 2011, available online.

Figure 15: Maybe Effect of Sales and Governemnt Support Is Too Small to Measure?



The figure shows the regression coefficients for the amount of Chinese innovation fund support given to firms and these firms' total sales on dependent variables like obtaining new patents, new product sales, increasing export volumes, increasing profits to sales and exports to sales. We multiplied these regression coefficients by 1000, as the effects were to small to show in a graphic. For new patents, new product sales, and export volumes, we show the true regression coefficients about the bar (namely 341, 314 and 422 out of one thousand). None of the authors' many models explained more than 5% of the variance in the original dataset.
Source: Guo et al. (2014).

Figure 16: Product Competitiveness Depends on Stakeholders More than Other Factors?



Non-statistically significant factors: acquisition of embodied technology (like machines), patent disclosure, suppliers, consultants, local universities and foreign universities, R&D capacity, manufacturing capability, and strategic planning capability.

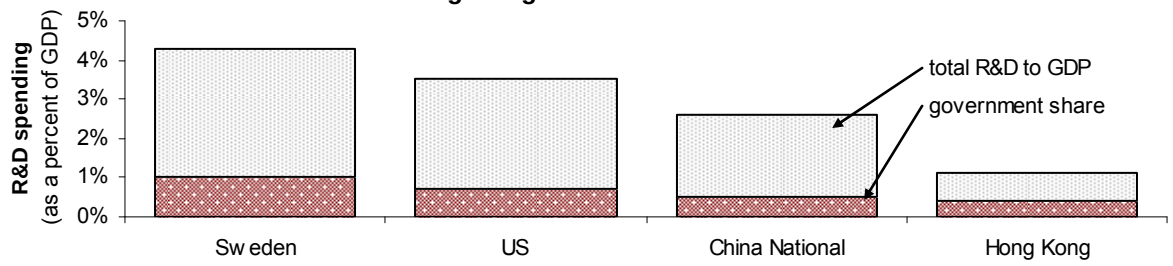
The figure shows the effect of a one standard deviation change in each of the variables shown on Hong Kong and Pearl River Delta companies' "product competitiveness." Source: Baark *et al.* (2011).

Similarly mixed evidence appears on the use of tax and other incentives to stimulate innovation-led growth. In their 16 year old paper, Tung and Cho find that tax incentives encourage investment.[54] Alix-Garcia *et al.* show that Shenzhen (and Hong Kong), as a well-studied export zone, would likely benefit far less from a Qianhai scheme than less developed urban areas.[55] If Shenzhen reacts to tax incentives the same way that Shanghai did, Zhu and colleagues' data predict that tax incentives will distort investment away from profit-increasing innovation in Qianhai![56]

[54] See Samuel Tung and Stella Cho, The impact of tax incentives on foreign direct investment in China, 9 Journal of International Accounting, Auditing and Taxation 2, 2000, available online.
[55] See also Jennifer Alix-Garcia, Anne-marie Schneider, and Na Zhao, Playing favorites: Tax incentives and urban growth in China, 1978-2010, 2014, available online.
[56] Ping-fang Zhu, Wei-min Xu and Nan-nan Lundin, The impact of government's fundings and tax incentives on industrial R&D investments—Empirical evidences from industrial sectors in Shanghai, 17 China Economic Review 1, 2006, available online.

Scholars and policymakers agree that any innovation policy must hinge on funding from private sector companies themselves. Figure 17 shows Hong Kong's R&D funding compared with other jurisdictions. As shown and oft-mentioned, Hong Kong spends less on R&D than other jurisdictions. Yet, as a proportion of total spending, the private sector supplies more money for R&D than the government. As the data from these other jurisdiction imply – Qianhai's innovative companies must rely more on private sector funding than government funding. **Qianhai's innovation system relies on market-based finance rather than government-based finance.**

Figure 17: Does the Qianhai-Model of Innovation-System Development Serve Hong Kong Better than a Scandinavian One?



The figure shows spending on R&D as a percent of GDP. The red part shows government R&D spending (as a percent of GDP) while the entire bar shows total spending. Such a dichotomization highlights the role of government versus private sector in funding R&D.
Source: Cheung et. al (2015) based on OECD and Hong Kong Government data.

What about the Hong Kong's role as a financial centre? Will Qianhai encourage funds to flow from Hong Kong's financial institutions to Shenzhen-based financiers and innovative companies? Li finds that changes in Hong Kong's stock market index "causes" changes in Shenzhen's – suggesting that funds do flow from Hong Kong north.[57] Qiao and colleagues and others also find integration between markets – and show that further deregulation of equity markets in Qianhai would lead to far more shareholding (depth).[58] Zhang presciently finds that Hong Kong direct investment in the Mainland should decrease as China's low labour costs evaporate.[59] Lee finds that Mainland exchanges provide more liquidity for issuers – casting further doubts on any advantages Hong Kong can provide in channelling money to innovative firms.[60]

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[57] At least. he finds integration in a study looking at how share price variance in one market translates to other markets. See Hong Li, International linkages of the Chinese stock exchanges: a multivariate GARCH analysis, Applied Financial Economics, 17:4, 2007, available online.

[58] Zhuo Qiao, Thomas Chiang,, Wing-Keung Wong, Long-run equilibrium, short-term adjustment, and spillover effects across Chinese segmented stock markets and the Hong Kong stock market, 18 Journal of International Financial Markets, Institutions and Money 5, 2008, available online. See also Anders Johansson and Christer Ljungwall, Spillover Effects Among the Greater China Stock Markets Long-run equilibrium, short-term adjustment, and spillover effects across Chinese segmented stock markets and the Hong Kong stock market, 37 World Development 4, 2009, available online.

[59] Indeed, Qianhai will have the effect of helping to equity returns to labour and capital in both markets. In this way, If Zhang's findings still hold, Qianhai-related integration should remove the advantages that cause(d) Hong Kong investors to invest on the Mainland in the first place.

[60] Hing-Wah Lee, The Price Premium of China A-Shares over Hong Kong H-Shares: A Further Visit of the Liquidity Hypothesis, 38 Asia-Pacific Journal of Financial Studies 5, 2009, available online.

Despite the linkages between Hong Kong and Shenzhen financial markets, share price changes do not provide enough information about changes inside the companies to prove useful for our study. Gul et al. for example show low levels of "synchronicity" (or the extent to which changes in share prices reflect firm-specific rather than market-specific factors) for Chinese equity markets [61] Even if share prices reflect company specific information in the short-run, they reflect economic fundamentals of China in the longer run.[62] Listing through some form of Qianhai scheme – where firms list in Hong Kong, Shenzhen, both or through some kind of "stock connect" programme – affects levels of cash at primary offering.[63] However, changes in share prices would have a much weaker link when trading on secondary markets. **Despite correlations between Hong Kong share prices and Shenzhen share prices, share prices in both jurisdictions do not contain enough firm-specific information to shed light on the relationship between finance and innovation.**

What about the other claim for Qianhai – that financial innovation (in the form of easier repatriation of RMB) could promote innovation? Beck and others (2012) find that financial innovation does indeed lead to growth.[64] Yet, they also find that such innovation fragilizes the banking sector – making crisis more likely. Chang shows that financial innovation leads to firm innovation.[65] The data – as shown in Figure 18 -- seem to suggest that foreign capital and foreign markets seem to encourage Chinese innovation.[66] Local investment, according to this study, does little to foster profit-oriented innovation. Figure 19, in contrast, shows that state-owned enterprises (SOEs) would have strong incentives to locate in Qianhai – despite the fact that such a location does not increase profits or necessarily lower costs.[67] To the extent that Qianhai might be considered as an "overseas listing" – these SOEs which list there would do worse than private firms. **Qianhai is thus likely to attract the least desirable companies for creating and sustaining new innovation – namely state-owned enterprises (SOEs).**

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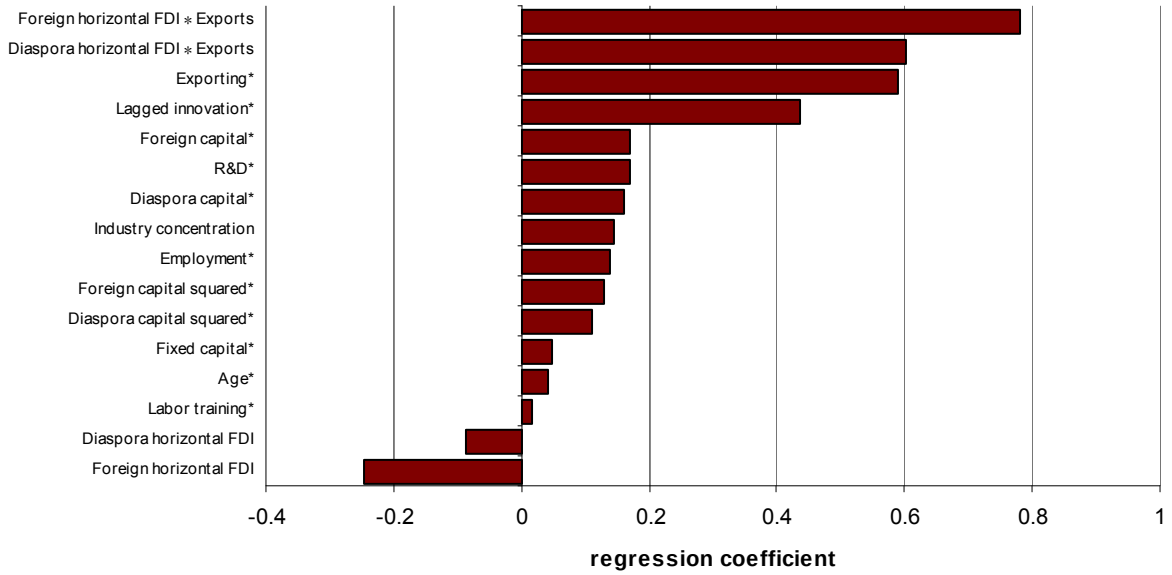
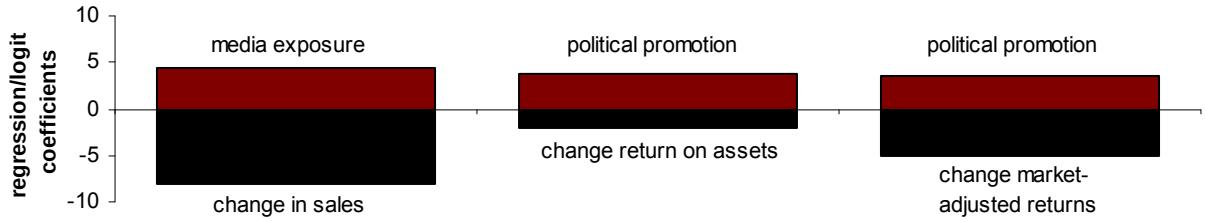
[61] Ferdinand Gul, Jeong-Bon Kim, Annie Qiu, Ownership concentration, foreign shareholding, audit quality, and stock price synchronicity: Evidence from China, 95 Journal of Financial Economics 3, 2010. Available online.
[62] Xiaohui Liu and Peter Sinclair, Does the linkage between stock market performance and economic growth vary across Greater China? 15 Applied Economics Letters 7, 2008, available online.
[63] Bas Karreman and Bert van der Knaap, The geography of equity listing and financial centre competition in mainland China and Hong Kong, 12 Journal of Economic Geography 4, 2012, available online.
[64] See Thorsten Beck, Tao Chen, Chen Lin and Frank Song, Financial Innovation: The Bright and the Dark Sides HKIMR Working Paper No.05/2012, 2012, available online.
[65] See Chang Xin, Yang-yang Chen, Qian Wang, Kuo Zhang, Wen-rui Zhang , The Real Effect of Financial Innovation: Evidence from Credit Default Swaps Trading and Corporate Innovation , available online.
[66] See Sourafel Girma, Yun-dan Gong and Holger Gorg, What Determines Innovation Activity in Chinese State-owned Enterprises? The Role of Foreign Direct Investment, 37 World Development 4, 2009,available online.
[67] Ming-yi Hung, TJ Wong, and Tian-yu Zhang, Political considerations in the decision of Chinese SOEs to list in Hong Kong, 53 Journal of Accounting and Economics 1, 2012, available online.

Figure 18: In SOEs at least, foreign investment good and domestic investment bad (unless the SOEs engages in foreign-oriented activity)



The figure shows the effect of the variables above on Chinese innovation. As shown, foreign direct investment, export orientation and R&D play pivotal roles in promoting innovation. See original study (Table 4) for variable definitions and econometric methods used.
Source: Girma (2009).

Figure 19: Poliitically Connected Would Choose Qianhai -- even if companies do worse



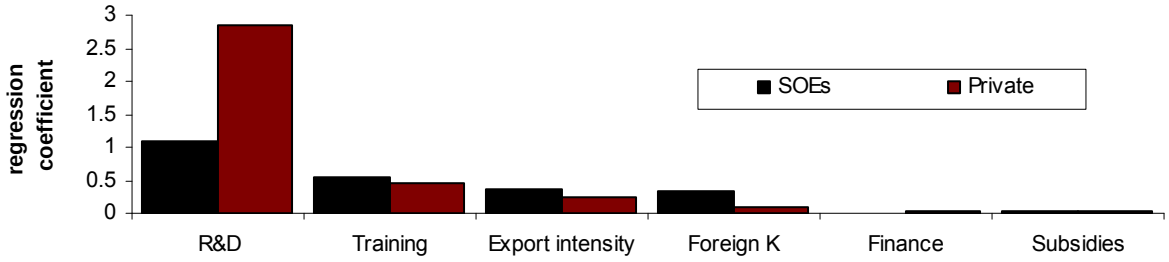
The figure shows the regression coefficients for each of the variables shown (above and below each bar) as the dependent variable. These coefficients refer to the effect that political connections play in deciding to list overseas. Overseas listing (if Qianhai would be considered like Hong Kong as "overseas") would help promotion prospects even if the foreign listing correlates with worse financial performance (lower sales, return on assets and cumulative adjusted returns of the company's shares). The toip coefficients refer to logit coefficients and the bottom to instrumental variables estimates. See econometrics textbook for more on these procedures.
Source: Hung et al. (2012).

More evidence seems to point toward the futility of the present Qianhai design. The two figures below undermine Qianhai's claims to promote innovation.[68] Figure 20 shows the effects of Chinese R&D, training, foreign capital, financial position, and subsidies on innovation levels. Figure 21 shows access to finance for Chinese innovators as a result of the same variables. As shown, internal financial position (retained earnings), foreign capital and subsidies play an

[68] Sourafel Girma, Yundan Gong and Holger Gorg, Foreign Direct Investment, Access to Finance, and Innovation Activity in Chinese Enterprises, 22 World Bank Economic Review 2, 2008, available online.

extremely marginal role in both fomenting innovation and attracting money. Interestingly, even though finance does not help individual firms innovate, the overall level of finance (credit) does correspond with higher rates of innovation outside of the Qianhai region![69] Zhao, for his part, finds that deeper credit markets (for central and western regions) and equity markets (for coastal provinces) incentivize innovation at the provincial level.[70] Hu and colleagues also find that foreign investment fails to promote the adoption of foreign innovations.[71] Thus, the preponderance of the evidence suggests that finance only promotes innovation indirectly – through a still undiscovered causal mechanism. Wu (as mentioned previously) further finds that companies with Hong Kong-based investors have less innovation than other types of investors. **If true, Qianhai's tax incentives and RMB repatriation mechanisms will have marginal, indirect effects on promoting innovation in the Hong Kong/Shenzhen region – and probably no effect at all.**

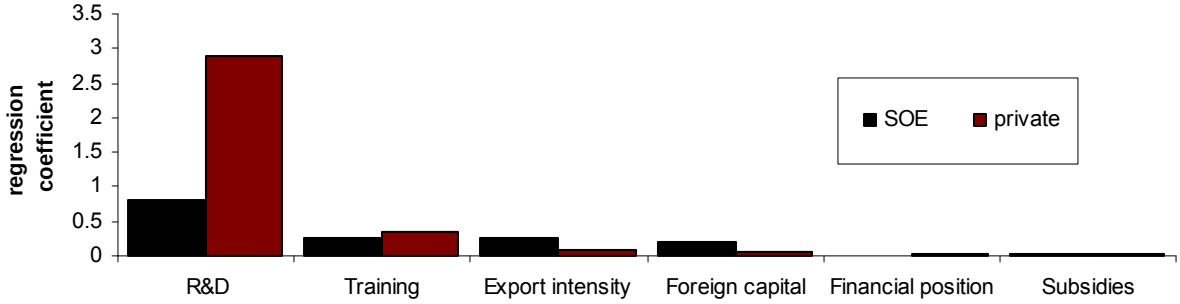
Figure 20: Is Access to Chinese Domestic Capital and Subsidies Useless for Innovation?



The figure shows the results of econometric analysis looking at the determinants of **INNOVATION** in Chinese companies. To the extent that Shenzhen's companies reflect the wider Chinese situation, then Qianhai would not help promote innovation by putting more finance and subsidies on offer. See source for empirical methods and variable definitions.

[69] See Aoife Hanley, Wan-Hsin Liu,, Andrea Vaona, Financial Development and Innovation in China: Evidence from the Provincial Data, 2011, available online.
[70] See Wen-feng Zhao, Financial Development and Regional Innovation Output Growth: Based on Empirical Analysis of Provincial Panel Data in China, 7 Modern Economy 1, 2016, available online.
[71] See Albert Hu, Gary Jefferson, Qian Jinchang R&D and Technology Transfer: Firm-Level Evidence from Chinese Industry, 87 Review of Economics and Statistics 4, 2005, available online.

Figure 21: Access to Chinese Capital Doesn't Depend on Foreign Investment or Subsidies?

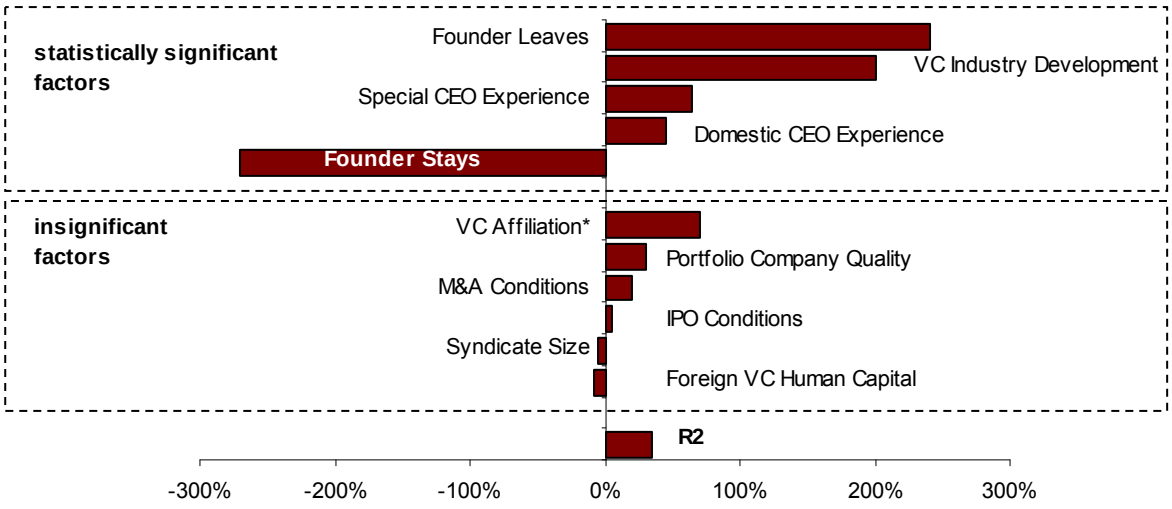


The figure shows the results of econometric analysis looking at the determinants of **FINANCE** (specifically bank loans) for Chinese companies. To the extent that Shenzhen's companies reflect the wider Chinese situation, then Qianhai would not help promote innovation by making putting more finance and subsidies on offer. See source for empirical methods and variable definitions.
Source Girma *et al.*, 2008.

What about private equity and venture capital? One might imagine that the rules of venture capital differ from other types of capital. Qianhai's focus on IT, finance, and logistics suggests that competencies can develop in these specialist areas. Yet, Liu and co-authors find that venture capitalists in the Qianhai area do not specialise by industry or in any other way.[72] Using econometric analysis, they find no evidence that venture capital-funded firms underprice their IPO share offering nor do they only choose the best (most potentially profitable) companies to work with.[73] Wang and Wang find that senior management (CEO) experience in the industry in which the venture capital firm is investing remains critical to the investment's profitability.[74] Figure 22 shows the way various factors affect the probability that a VC investment goes IPO. As shown, for companies with a former industry insider CEO-turned-venture-capitalist, the investee has about a 60% greater likelihood of going IPO. In a more recent paper, they also find larger post-IPO share price increases for firms with foreign venture capitalists.[75] In the Qianhai context, one might interpret these findings in such as a way as to argue that Hong Kong venture capital can help add value to Shenzhen-based companies planning on listing (and others).

[72] Yu-can Liu, Xiao-min Gu, Jie-ting Chen, The Role of Venture Capital in IPOs: Evidence from Shenzhen Stock Market, available online.
[73] These results do not necessarily hold for the entire Chinese equity market. Wu and colleagues, for example, find evidence of venture capitalist under-pricing during their investee companies' IPO – and delimit five conditions which affect the extent of such under-pricing. See Cui-feng Wu, Shi-nong, Wu and Jing Yang, The Role of Venture Capital in China's Listed Companies on the GEM: Certification or Grandstanding?, 2012, available online.
[74] See Lan-fang Wang, , Su-sheng Wang, Cross-border venture capital performance: Evidence from China, 19 Pacific-Basin Finance Journal 1, 2011, available online.
[75] Yin He, Bin Li, Yun-hua Tian, Li-jun Wang, Does Foreign Venture Capital Provide More Value‐Added Services to Initial Public Offering Companies in China? 24 China & World Economy 2, 2015, available online.

Figure 22: Chinese Industrial Magnates, Rather than VC Specialists Make for the Best Investors

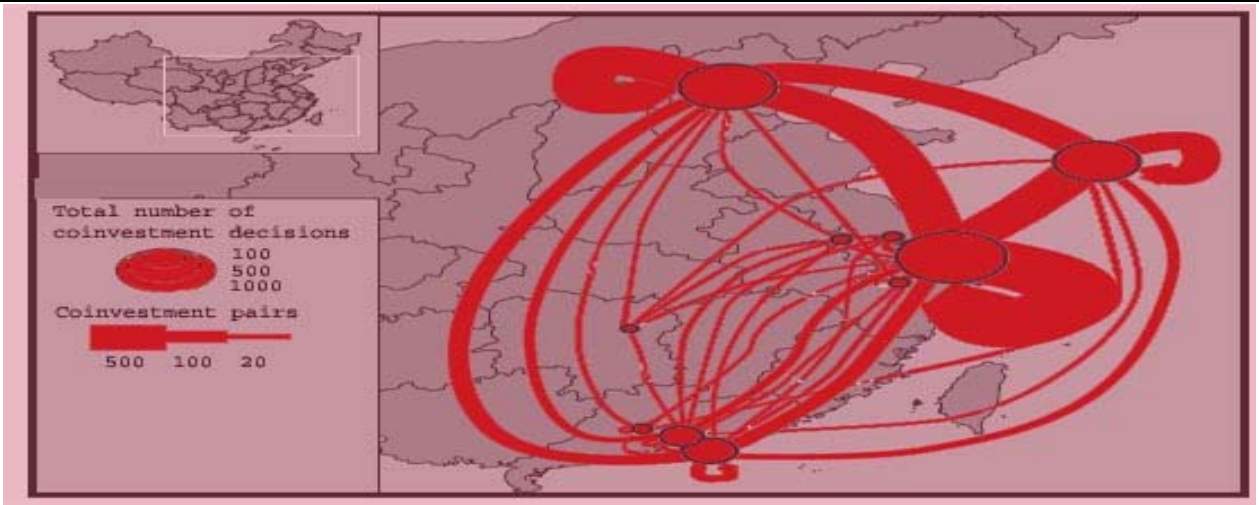


The figure shows the extent to which the factors shown affect a Chinese company's prospects of going IPO. We have changed the scale for this logit regression – to make more clear that an effect of 100% or more means that the probability of going IPO changes by one standard deviation or more.
Source: Wang and Wang (2010).

Will Qianhai add to the stock of innovation or simply displace innovation from other parts of China? Figure 23 shows the flows of venture capital funds destined for China.[76] Authors like Fan and Wan argue that Shenzhen (and Hong Kong) can produce innovation without government support of high-tech parks – and such support results in unnecessary "inequality in innovation capacity."[77] In other words, government policy shifts R&D geographically, rather than increasing innovation in the China region. Shenzhen has access to money and ideas – many of which may serve Shenzhen-based firms with locations outside of Guangdong.[78] Even if Shenzhen does manage to fill out (with high tech firms), several authors have questioned whether non state-owned enterprises could innovate in a policy environment hostile to them.[79] Strong centrifugal forces tend to push finance (and thus potentially innovation) to Beijing and Shanghai.[80]

[76] See Jun Zhang, The spatial dynamics of globalizing venture capital in China, A Environment and Planning 43, available online.
[77] Pei-lei Fan and Guang-hua Wan, China's Regional Inequality in Innovation Capability, 1995-2004, United Nations University Research Paper No. 2006/153, available online.
[78] For more on the Chinese Innovation System, and Shenzhen's place in it, see Josef Bichler and Christian Schmidkonz, The Chinese Indigenous Innovation System and its Impact on Foreign Enterprises, Munich Business School Working Paper 2012-01, available online.
[79] Wei Zhao and Rigas Arvanitis, The Innovation and Learning Capabilities of Chinese Firms: Technological Development in the Automobile and Electronics Industries, 42 Chinese Sociology and Anthropology, 3, 2010, available online.
[80] Even though the Zhao et al study appeared in the early 2000sSimon Zhao, Li Zhang and Danny Wang, Determining factors of the development of a national financial center: the case of China, 35 Geoforum 5, 2004, available online.

Figure 23: Would Qianhai Simply Divert Money Going To and Coming From China?



source → sink ↓	Beijing	Shanghai	Shenzhen	Hong Kong	Overseas
Beijing	3595	490	29	240	749
Shanghai	392	3248	123	205	973
Shenzhen	72	159	229	301	85
Hong Kong	26	16	0	60	0
Other	850	1323	334	327	226

The figure shows the paths of co-investment funding among China's and foreign venture capitalists and the amount of venture capital funding in 2008

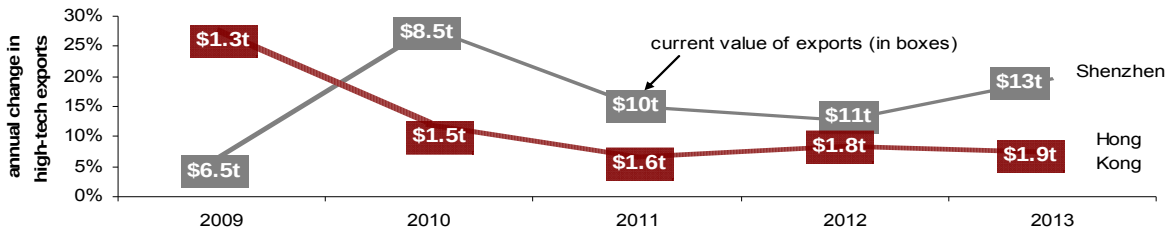
Source: Zhang (2011).

Thus, the literature points to **three robust conclusions**. First, money spent on innovation by local governments will likely be wasted. Any design for Qianhai should encourage foreign investment – preferably using Hong Kong and a conduit for foreign investment rather than as a source of investment itself. Second, joint research projects, platforms, and university joint ventures will determine the way of promoting innovation in the region. Third, the current structure of Qianhai will likely have no effects on innovation in the region. Policymakers must pursue another design – focused on harmonizing institutions – rather than investment regimes – across the Shenzhen/Hong Kong border.

Looking Specifically at the Qianhai Region

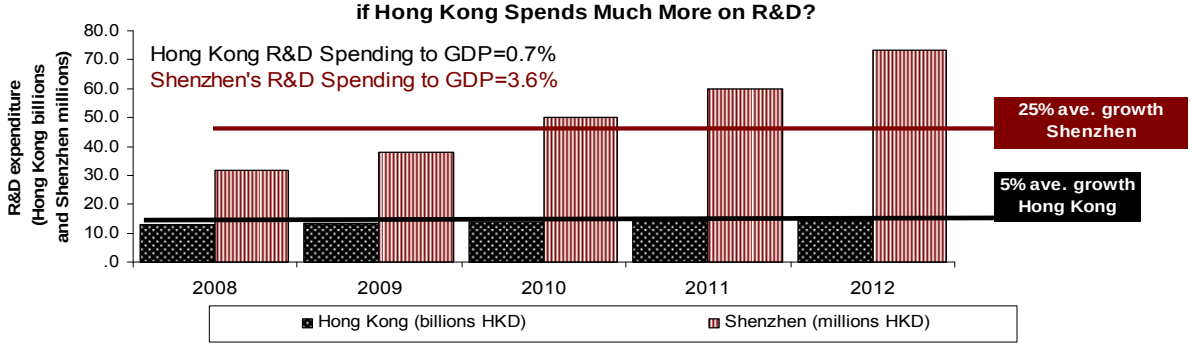
Hong Kong seems to be losing the race for innovation. Figure 24 shows the extent of high-tech exports coming from Shenzhen and Hong Kong. As shown, both trends (for Shenzhen and Hong Kong) appear relatively stable in recent years – with average growth of around 10%-ish.[81] Yet, Shenzhen exports one magnitude more in high-tech export values than Hong Kong – while keeping its growth rates generally higher than Hong Kong's. Naturally, Shenzhen must invest more in R&D – otherwise how can it maintain such a lead? Figure 25 shows that Shenzhen's companies produce far more results with far less R&D spending. We see that Shenzhen's R&D spending has rocketed in recent years (averaging around 25% average growth). Yet, Shenzhen's base for such R&D comes in at three orders of magnitude lower than Hong Kong's. As such, **Shenzhen can turn orders of magnitude <u>less</u> R&D spending into orders of magnitude <u>more</u> high-tech exports.**

Figure 24: Can Integration via Qianhai Make Up for Hong Kong's Lagging High-Tech Exports?



The figure shows the rate of change (in Hong Kong dollar terms) of high-tech exports from Shenzhen and from Hong Kong for the years shown. See appendix for exchange rates used (Shenzhen data provided in RMB and USD terms). We show the current value of these exports (in trillions of HKD) in the boxes corresponding with each year. For example, the growth rate of Shenzhen's high-tech exports fell from 30% in 2010 to 15% in 2011 - with a corresponding increase in these exports from HK$8.5 trillion to HK$10 trillion. Source: Shenzhen Statistics Office (2015) and Hong Kong Annual Digest of Statistics (2015).

Figure 25: Why Does Shenzhen Commercialize Far More Products if Hong Kong Spends Much More on R&D?

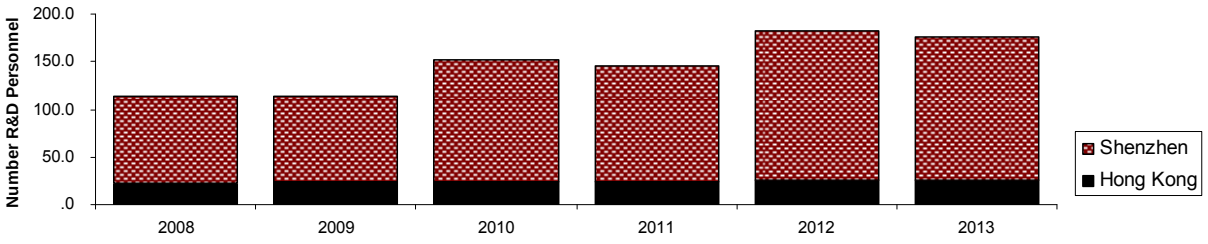


The figure shows R&D expenses for Shenzhen and Hong Kong-based companies for the years shown (in nominal Hong Kong dollar terms). We also show the average growth rates for the period for this expenditure -- both for Hong Kong and Shenzhen. R&D spending in Shenzhen has grown five times as fast as such expenditure in Hong Kong -- suggesting a desire to catch up. Could giving Shenzhen access to Hong Kong's R&D via Qianhai "rationalize" R&D spending across both jurisdictions? Source: Hong Kong Digest of Statistics (2015) and Shenzhen Statistics Office (2015).

[81] The Hong Kong government provides superlative statistics on its innovation-related activities for researchers and others. The 2014 version of its Innovation Activities Statistics contains almost 80 pages of data (excluding explanations, methodological descriptions, etc). We do not cover most of the report's data – in order to focus on our Qianhai-related hypotheses. See Census and Statistics Department, 2014 Innovative Activities Statistics, 2015, available online.

The data on patents and researchers in both jurisdictions shed light on these findings. Figure 26 shows the amount of researchers engaged in both jurisdictions.[82] As shown, Shenzhen employees about 10 times more R&D staff than Hong Kong. If Hong Kong's R&D spending really comes to 5,000% of Shenzhen's and if its researchers come to only 10% of those in Shenzhen, and if they really have the same productivity, then Hong Kong's R&D staff are 500 times more expensive than Shenzhen's![83] Similarly, as shown in Figure 28, these researchers have produced far more patents than Hong Kong's – who have managed to file fewer patents (despite similar growth in researcher numbers). In the same way, to the extent that Hong Kong files about 10% of patents Shenzhen does (we round out the data from Figure 26 in order to make our comparison comparable with the previous one from Figure 25), Hong Kong's patents remain 500 times more costly than Shenzhen's. These numbers look suspicious – so we do not want to rely too much on this figure. Nevertheless, the general lesson illustrated by these data probably remains valid. **Hong Kong has R&D size, but Shenzhen has growth which could energize Hong Kong's own lacklustre performance in encouraging profit-led innovation.**

Figure 26: Shenzhen Brings Vastly Superiour Numbers of R&D Staff to the Qianhai Project

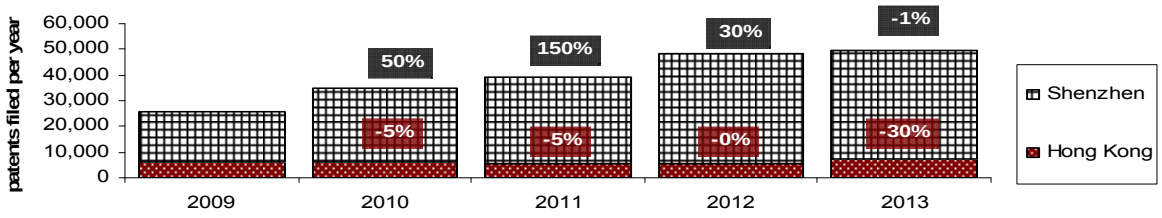


The figure shows staff engaged in R&D in Shenzhen and Hong Kong for the dates shown. Different data definitions and differences in wage probably explain a large part of the difference in the size of Shenzhen's and Hong Kong's R&D talent pools. Yet, the pool exists nevertheless for Hong Kong companies to exploit in a Qianhai style collaboration. We look at profit data later to show the extent to which the marginal productivity of R&D staff in Shenzhen matches that of Hong Kong's.
Source: Shenzhen Statistics Office (2015) and the Hong Kong Statistics Digest (2015).

[82] We used different data sources, with (in all likelihood) different definitions of R&D spending and other data definitions. Readers should keep in mind the problems of Mainland data when looking at any direct comparisons we make between Hong Kong and Shenzhen.

[83] We took the level of R&D spending from Figure 25 (remembering that the figure expresses Hong Kong's spending in billions rather than millions) and divided by the number of researchers (shown in Figure 26). These numbers look suspicious, so we do not wish to highlight these results too much.

Figure 27: If Hong Kong Can Grab Even Part of Shenzhen's *Elan* ....

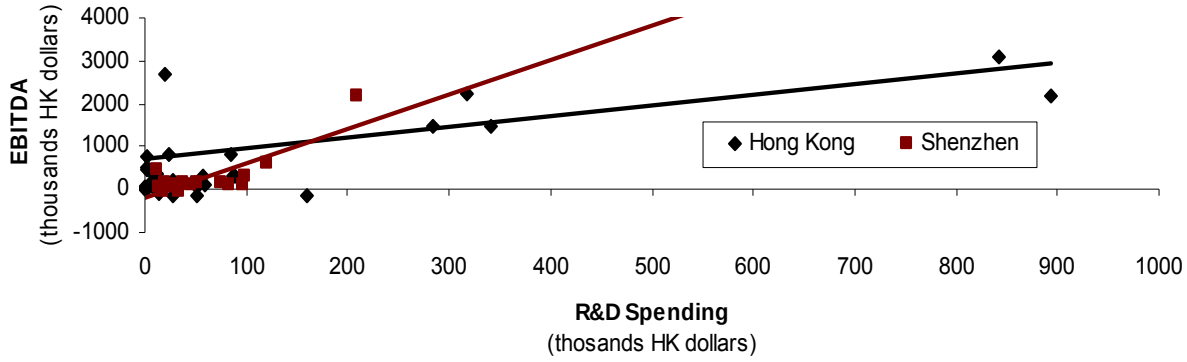


The figure shows the number of patent applications made in each of the Qianhai component jurisdictions (whether successful or not). As shown, Shenzhen's patent applications weigh in at 5 times those of Hong Kong. Given their similar population sizes, is Shenzhen five times more innovative than Hong Kong? In any case, given Hong Kong's lackluster growth in patent applications, contributing to a common patent pool could give Hong Kong a much-needed patent boost.
Source: Shenzhen Statistics Office (2015) and Hong Kong Statistical Digest (2015).

The micro-level data support many of the conclusions shown above. In our own study (as described in our statistical appendix), we used the financial statements of Hong Kong and Shenzhen companies working in the sectors that Qianhai's policymakers want to target – logistics, IT, finance and creative industries. Figure 28 shows earnings before interest, taxes, depreciation and amortization (or EBITDA, which we use as proxy for company profits due to innovation rather than financial or other strategies). The figure also shows R&D spending – for Hong Kong and Shenzhen-based companies for the latest year available. Confirming our previous findings, Shenzhen-based companies appear to turn R&D spending into profits more efficiently than Hong Kong-based companies (as shown by the steeper line of best fit). Yet, turning the figure on its side, we see (if we use EBITDA as the independent variable) that Hong Kong spends far more profits on R&D than Shenzhen – again confirming the findings above. Because of feedback between R&D and profits, though, these data give nothing more than a rudimentary first glance at the possible relationships present. **Yet, we might hypothesize that Shenzhen is better at turning R&D spending into profits, whereas in Hong Kong is better at turning profits into R&D spending.**[84]

[84] Such a statement does not represent a tautology. As we describe in the Appendix, R&D spending probably "feeds back" into EBITDA and visa-versa. It is entirely possible that causality between R&D spending and EBITDA occurs one way for Shenzhen-based companies and another way for Hong Kong based companies.

Figure 28: Before Controlling for Other Factors, Shenzhen Seems to Turn R&D into Profits More Effectively

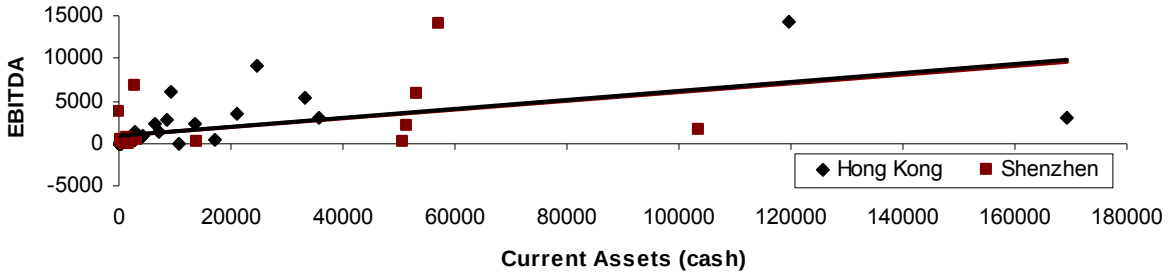


The figure shows the apparent relationship between R&D spending and EBITDA for companies in Qianhai's favoured industries (logistics, financial services and technology). We show the simple line of best fit for Hong Kong and Shenzhen between the 2014 (or latest year available) data. Without econometric analysis, these data could be meaningless.
Source: based on data from Compustat. See full paper for more details.

If Hong Kong and Shenzhen might handle profit generation and R&D spending from that profit differently, companies' cash-on-hand seems to do no better from on jurisdiction to the other. Figure 29 shows the relationship – before controlling for factors which can confuse this relationship – between EBITDA (as a measure of profits) and current assets (as a measure of cash on hand). Companies in both Shenzhen and Hong Kong appear to use cash to the same extent to generate profits – or visa versa.[85] Cash may come from investment needed to engage in R&D, and thus generate profits. Or profits may result in extra cash needed to invest in R&D. As Figure 30 shows, companies in Shenzhen engage in more R&D as a proportion of their total assets than Hong Kong companies (even though they may be smaller in size than Hong Kong companies in absolute terms). Just from comparing Figure 28 and Figure 30, it seems that more R&D spending correlates with higher profits in the Qianhai region. Yet, these data do not control for outside factors, for the feedback between the variables or the way these variable should interact.[86] **Clearly then for innovation companies in the Qianhai region, R&D spending, profits, and cash available (from/for investment) clearly form an interdependent system.**[87]

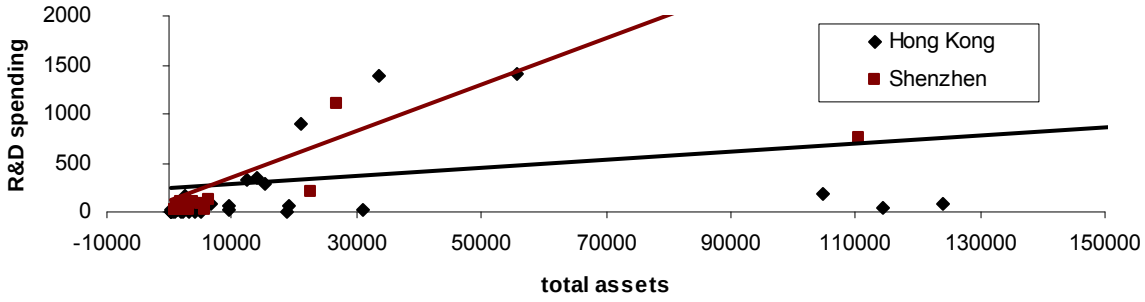
[85] We have plotted EBITDA on the y-axis, traditionally the location of the dependent variable. Feedback between these variables results in endogeneity which prevents one from talking about a strictly independent or dependent variable.
[86] "Should interact" refers to the way these variables change in equilibrium and over time. We care much less about the changes of the day than on the long-term way these variables change in equilibrium in response to innovation.
[87] How do we know this is true? How would we know if part of this relationship actually does not hold? If we observed a straight line relationship between any of our variables, then they would not depend on each other. As these variables clearly depend on each other, we know that the relationship we described in the main text exists. We can not know though yet how dependent these variables are.

Figure 29: Both Jurisdictions Seem to Similarly Transform Investable Cash into Profits



The figure shows current assets and EBITDA for 2014 (or the latest year avaiable) for companies in Hong Kong and Shenzhen in the industries targeted by Qianhai (technology, logistics and finance). Before using econometric methods to control for outside effects, companies from both cities seem to turn cash into profits (and visa versa) similarly. Source: based on data from Compustat. See full paper for more details.

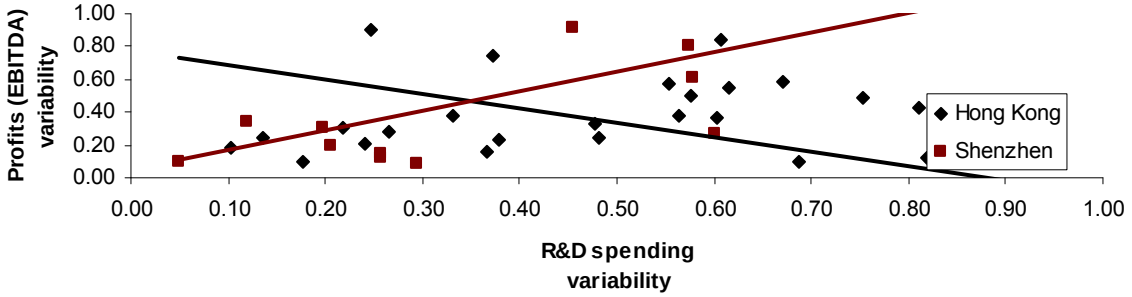
Figure 30: Shenzhen's Companies Do More R&D with Fewer Assets



The figure shows R&D spending and total assets for 2014 (or the latest year avaiable) for companies in Hong Kong and Shenzhen in the industries targeted by Qianhai (technology, logistics and finance). Shenzhen-based companies show a trend of spending more (as a percent of total assets) in R&D -- as shown by the steeper line of best fit. Source: based on data from Compustat. See full paper for more details.

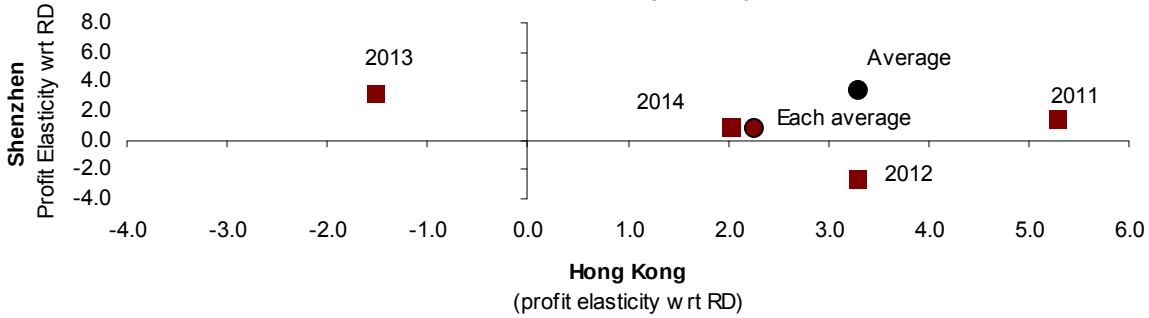
What do the linkages between profits, R&D spending and investment/cash look like in the Qianhai region? Figure 31 provides some hints about this relationship. The figure shows the extent to which variability in R&D has passed into (or at least correlates with) the variability of EBITDA – or visa-versa. For Shenzhen-based innovative companies (before trying to control for outside influences), variability in EBITDA and R&D spending seemed to go hand-in-hand. For Hong Kong, variability of EBITDA decreased as R&D variability increased. Figure 32 shows the same information – showing how profits have changed over time as R&D spending changed (for Hong Kong and Shenzhen). Overall (across years on average), innovative companies' profits correlated with growth in R&D spending. **Despite differences in the way Hong Kong and Shenzhen companies turn R&D into profits, R&D spending does seem to translate into profits in both jurisdictions.**

Figure 31: Why Do Hong Kong Companies' Profits Become More Stable as R&D Spending Fluctuates More Wildly?



The figure shows the relationship between the way that companies' EBITDA varies over time in comparison to their R&D spending. Technically speaking, we use the standard deviation for the period 2010 to 2015 of the variables shown divided by the average value over the period (to make the numbers comparable across companies). The negative relationship for Hong Kong companies means that changes in R&D spending fail to pass into changing profits -- a bad sign if we think that R&D spending drives profits in Hong Kong.
Source: Compustat (2016).

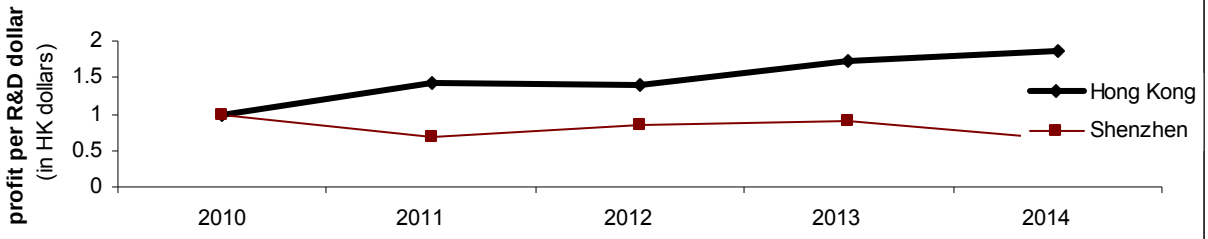
Figure 32: In our sample at least, Hong Kong Companies' Profitability Remains More Sensitive to R&D Spending than Shenzhen's



The figure shows the extent to which profits contemporaneously changed as R&D spending changed for innovative companies in our sample from Shenzhen and Hong Kong. Overall, such a profit elasticity with respect to R&D spending remained positive (with exceptions in 2013 for Hong Kong and in 2012 for Shenzhen).
Source: based on data from Compustat (2016).

The micro-level data tell a very different story from the one we told previously about profit per R&D dollar. Figure 33 shows the way that EBITDA changed over time for each dollar the companies in our sample spent on R&D. At first sight, Hong Kong's higher profit-per-R&D dollar suggests that such R&D should be conducted in Hong Kong. However, Shenzhen companies' R&D investment represents double Hong Kong's (up from six times in 2010). Clearly, any type of sharing or pooling arrangement which allowed innovative companies to combine R&D scale with efficiency would generate more profits. **As such, these data suggest a Qianhai scheme should result in more and better R&D for generating profits.**

Figure 33: Hong Kong's Innovation-Led Profits Per R&D dollar Would Be $16 million per company higher if they invested as much in R&D?



$16 million
higher per company

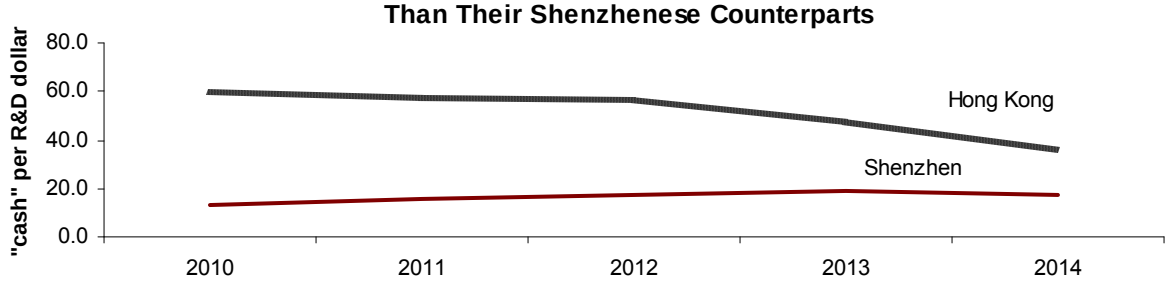
Profits in Hong Kong if its companies spent as much on R&D as Shenzhen-based companies (given Shenzhen's profit-per-R&D dollar ratio)..

The figure shows the profit per R&D dollar for the innovative sector companies in our sample from Hong Kong and Shenzhen. Unlike in the macro-data, Hong Kong companies' profits-per-R&D dollar come in higher than Shenzhen's. We have no explanation, other than wonky aggregate data, as an explanation. The estimated $16 million per company in extra profits comes from multiplying Hong Kong's higher profit-to-R&D expense ratio by the amount of money Shenzhen companies spent in R&D.
Source: Computstat (2016).

What about growing Hong Kong (and Shenzhen) as (a) financial centre(s)? Do more profits and R&D spending lead to more bankable investable – namely cash companies can use to pursue innovation?[88] Figure 34 shows cash-per-R&D dollar for innovative Hong Kong and Shenzhen companies in our sample. As shown, Hong Kong companies have had higher levels of current assets, relative to their R&D spending, than their Shenzhen counterparts. The difference mostly attributes to R&D spending levels. Shenzhen companies have spent around 3 times more on R&D than they held in cash-like assets. We can not know the motivations for holding current assets – or their relationship with investment and innovation. However, for lack of a better measure – and in combination with a variety of other indicators which we describe in our study – **we can see how the proposed Qianhai scheme might change the nature of the link between profits, R&D spending and cash/investment.**

[88] We look at cash in this paper rather than other kinds of investment (like value of bonds sold, shares issued/traded, and so forth) for three reasons. First, responding to new market opportunities requires liquidity. Second, innovative companies often have the most difficulty obtaining vital finance usable now. Because investors can not value these new ideas, they often remain reluctant to fund new, innovative projects. Third, we can not know whether retained earnings, bond proceeds or share proceeds fund innovation. So we assume that businessmen will use some money for investment in innovation and keep the rest for a rainy day. Thus, current assets remain the best indicator for looking at the value of money usable for investment.

Figure 34: Hong Kong's Innovative Attract (Sit On?) Much More Cash Than Their Shenzhenese Counterparts



The figure shows the ratio of current assets (broadly interpreted as cash) and R&D spending for the sample of companies we analyse in-depth in this paper. Shenzhen's companies have started to catch up -- generating more cash. Such data of course do not tell whether more R&D spending has led to more cash or visa-versa.
Source: based on data from Computstat (2016)

The Legal and Administrative Design of a Qianhai Modern Service Industry Cooperation Area

Legal background

In theory, Qianhai represents a special economic zone comprised of two special economic zones – Shenzhen and Hong Kong. Yet, the *dirigiste* approach to lawmaking around the Qianhai scheme seems to run counter to the laissez-faire approach which has made Hong Kong successful in the past.[89] Yet, unlike *digisime* French-style, Chinese administrative law governing Qianhai relies far more on political statements than actual lawmaking as commonly understood in the West.[90] The *Overall Development Plan of Qianhai Shenzhen – Hong Kong Modern Service Industry Cooperation Zone* sets out – in an almost brochure-like format – the major elements of the proposed Qianhai development project in 2010.[91] These include features like the bonded port, the target industries, and the desire (for a lack of a more appropriate legal concept) to ease financial regulations.

Two years later (in 2012), the adopted *Supporting Policies of the Development and Opening up of Qianhai Shenzhen–Hong Kong Modern Service Industry Cooperation Zone of Shenzhen* represent a repeat of many of the items described in the Overall Development Plan – with the use

[89] Dirigism refers to the (French) philosophy in administrative law encouraging government to allocate resources through administrative act – rather than allowing market actors to fully make these decisions. For more on the Chinese dirigiste approach, see Jean-Francois Huchet, From Dirigisme to Realism: Chinese Industrial Policy in the Era of Globalisation, In Xavier Richet, Violaine Delteil and Patrick Dieuaide, Strategies of Multinational Corporations and Social Regulations, 2014, Springer, available online.

[90] Backer provides a useful discussion of the role of speeches by senior Communist Party officials in setting rights and obligations for executive administrative action. Xu, on the other hand, provides a fascinating and useful explanation for such an "abstract" method of regulating executive action (as the provinces hold much more power than the central level and as such persuasion represents the main tool of influence). See Larry Backer, Party, People, Government, and State: On Constitutional Values and the Legitimacy of the Chinese State-Party Rule of Law System, 30 Boston University International Law Journal 1, 2012, available online. See also Cheng-gang Xu, The Fundamental Institutions of China's Reforms and Development, 49 Journal of Economic Literature 4, 2011.

[91] See The State Council's Approval of "The Overall Development Plan of Qianhai Shenzhen – Hong Kong Modern Service Industry Cooperation Zone." Guo Han (2010) 86, Aug 26, 2010, available online.

of more commanding language.[92] Following the biannual pattern of "lawmaking", the *Authority of Qianhai Shenzhen-Hong Kong Modern Service Industry Cooperation Zone Objectives of Reform and Innovation in 2014* represents a set of instructions to the Qianhai Authority to engage in particular tasks (like "to close the Pingnan railway acquisition negotiation as soon as possible").[93] [94] In the Overall Development Plan, the text gives instructions to private actors as "one must..." without defining who specifically must comply.[95] Many of the provisions admonish organisations like banks, law firms and international schools to expand cooperation with Hong Kong (and visa versa!).[96]

Such lawmaking takes place against the background of policy-cum-lawmaking aimed at promoting integration in the Guangdong region (including Hong Kong, Shenzhen and the Guangzhou region). The two agreements for the liberalisation of trade in services represent the most parts of that cooperation. *The Agreement between the Mainland and Hong Kong on Achieving Basic Liberalisation of Trade in Services in Guangdong* signed at the end of 2014 represents one of the more important aspects of the Agreement for our purposes.[97] The Agreement further develops the "most favoured treatment" principle. Such a principle requires that, in terms of mutual recognition of service-related law, Hong Kong and the Mainland will apply the most "favourable" treatment offered to any other party.[98] The document does not define what "less favourable" means – leaving it up to executive agencies to decide. More worryingly, Annexes I and II of the Agreement provide a 220 page list of exempted services (basically everything!) and descriptions of the types of cooperation that specific types of services might form.[99] The *Agreement on Trade in Services* (signed the next year in 2015) basically represents a restatement of the previous year's agreement.[100] [101] **Despite claiming to value the principle of**

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[92] State Council, Approval of The State Council on "The Supporting Policies of the Development and Opening up of Qianhai Shenzhen–Hong Kong Modern Service Industry Cooperation Zone of Shenzhen, State Council Document No. (2012)58, 2012, available online.

[93] See Authority of Qianhai Shenzhen-Hong Kong Modern Service Industry Cooperation Zone Objectives of Reform and Innovation in 2014, Shen Ban Zi (2014) 4, 2014, available online at 35.

[94] The document containing these procedures also includes a number of specific policies aimed at financial institutions. The discussion of policies/laws aimed at building joint/common financial markets between Hong Kong and Shenzhen could fill a second, larger paper. Thus, we avoid any discussion of the relevant financial policies (except those specifically focused on promoting scientific and technological innovation). Anyway, recent studies have shown that financial market liberalisation policies will have less of an effect than anticipated. See Hung-Gay Fung, Jot-Zhang, and Gai-yan Yau, Reported trade figure discrepancy, regulatory arbitrage, and round-tripping: Evidence from the China–Hong Kong trade data, 42 Journal of International Business Studies 1, 2011, available online.

[95] The State Council's Approval of "The Overall Development Plan of Qianhai Shenzhen – Hong Kong Modern Service Industry Cooperation Zone." Guo Han (2010) 86, Aug 26, 2010, avialable online.

[96] The visa versa part of the Policies represents a concern – as in theory the central government has no authority to issue orders to private institutions in Hong Kong under the Basic Law.

[97] See Mainland and Hong Kong Closer Economic Partnership Arrangement (CEPA) Agreement between the Mainland and Hong Kong on Achieving Basic Liberalisation of Trade in Services in Guangdong (signed on 18 December 2014), available online.

[98] Service Trade Agreement, 2015, available online, at chap.3, art. 4.

[99] See The Mainland's Specific Commitments on Liberalisation of Trade in Services for Hong Kong, available online, at Table 1, p. 3.

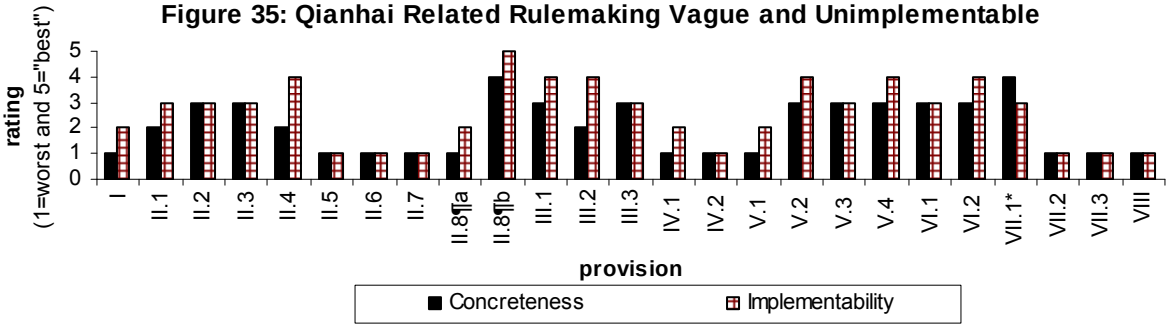
[100] Hong Kong has not yet submitted its list of restrictions. If Hong Kong wants to promote integration, its public officials should not ask for many such exemptions. See available online.

[101] The Comprehensive Plan for Shenzhen (2007-2020) also supposedly provides policies for economic integration between Hong Kong and Shenzhen. However, we could not find a copy of the Plan online.

most favoured treatment, both jurisdictions actively and highly regulate such trade.[102] Qianhai thus represents an opportunity for such liberalisation without the politically unpalatable effects on the whole city (cities).

Administrative rulemaking for Qianhai represents a serious hindrance for the scheme. Qianhai's *Supporting Policies* provide an example of the style of administrative lawmaking for the Qianhai region. These policies represent a typical abstract statement of policy goals and desires (for lack of a better word).[103] The wording consists of numerous statements like "innovation shall be promoted" without reference to a specific organisation or goals.[104] At least 12 regulations have such a format, providing competencies to numerous executive agencies to engage in further rulemaking. Figure 35 shows the concreteness and implementability of each provision in the *Supporting Policies* (as compared to law from other countries and measured on a scale from 1 to 5). Concreteness relates to the extent that the provision provides specific rights and/or obligations resulting in specific actions. Implementability relates to the extent that executive agencies can actually implement the provision given their budget, resources and competencies. As previously mentioned, many of the *Supporting Policies* provisions relate to political wishes rather than the detailed partitioning of rights and responsibilities typically associated with administrative law.

Figure 35: Qianhai Related Rulemaking Vague and Unimplementable



The figure shows ratings of the concreteness and implementability of each provision of the *Supporting Policies* adopted by the State Council for Qianhai. Concreteness specifically measures the extent to which provisions set up specific, measurable, achieveable, realistic and time-bound (SMART) activities. Implementability specifically refers to the likely ability (authority, administrative capacity, etc.) for the State Council and the institutions it directs to achieve the stated purpose of the provision. Source: State Council (2012).

Qianhai-related rulemaking also fails to provide a clear division of authority or responsibilities. In the case of the *Supporting Policies*, they vests authority in at least 8 institutions to make further rules. These include the National Development and Reform Commission, the People's Bank of China, China Banking Regulatory Commission, China Securities Regulatory

[102] In its information note, the Hong Kong government claims that favourable treatment covers about 95% of all services. Yet, a close look at the negative and positive lists given in the Agreement places this claim very much in doubt.

[103] See Supporting Policies at 30.

[104] Unsurprisingly for readers familiar with Chinese administrative law, much administrative lawmaking consists of political objectives (ie. "promote harmony and growth in a socialist system.") The arbitrary and capricious nature of administrative action on the Mainland thus flows inexorably from the nature of its administrative law. For a fascinating discussion of the role of political statements as quasi-law, see Jian-fu Chen Chinese Law: Context and Transformation, 2008, available online.

Commission and China Insurance Regulatory Commission.[105] The *Framework Agreement on Hong Kong/Guangdong Co-operation* also calls on the Guangdong Provincial People's Government to engage (abstractly) in cooperation.[106] The *Authority of Qianhai Shenzhen-Hong Kong Modern Service Industry Cooperation Zone Objectives of Reform and Innovation* (Authority Objectives) document further represents a calling on various agencies (mostly financial like the SAFE or insurance regulator) to make rules.[107] **Despite the stated aim of simplifying regulations and business in Qianhai, the regulatory structure of the region will likely mushroom into an unwieldy mesh of political objectives posing as regulations.**

All indications suggest that the Mainland government will adopt many more political objectives dressed up as regulations. Government's regulation of venture capital in the region provides yet another example.[108] That law gives the Municipal Technology Administrative Authority power to oversee a Venture Capital Association – a mandatory sector grouping for venture capitalists.[109] Strangely, the law provides for the self-regulation of the sector in Chapter VII while providing for government regulation in article 5(4). The law further gives the Municipal Industrial and Commercial Authority the mandate to vet applications – except for applications made by foreigners (which the Municipal Foreign Trade and Economic Cooperation Authority handles).[110] In theory, investors would agree to register as a "venture capital institution" in order to qualify for the application of preferential policies.[111] Yet, the law does not define these policies – only promising to draft these policies later. Almost 15 years later, the only noticeable preferential policy consists of slight tax relief.[112]

Hong Kong's agreements with the Mainland fail to agree on principles in order to sign numerous agreements which cover micro-issues. The Hong Kong government only provides information online about 7 frugally-worded agreements; including the 2013 Mainland/Hong Kong Science and Technology Co-operation Committee Agreement, an Intent on Co-operation in Innovation and Entrepreneurship Base for the Youth in Shenzhen and Hong Kong (also from 2013), a 2010 Agreement on Joint Promotion of Hong Kong/Guangdong Industry-Academia-Research Co-operation and other good-sounding abstractions like "innovation circles" and "innovation platforms"[113] Even within the law profession, a large group of rules still fail to provide an adequate basis for cross-border legal work.[114]

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[105] Supporting Policies at II.8.
[106] Id at VIII. See also Framework Agreement on Hong Kong/Guangdong Co-operation, LC Paper No. CB(1)1559/09-10(01), 2010, at Annex A and B, available online.
[107] See Authority of Qianhai Shenzhen-Hong Kong Modern Service Industry Cooperation Zone Objectives of Reform and Innovation in 2014, Shen Ban Zi (2014) 4, 2014, available online at 35.
[108] See Regulations of Shenzhen Special Economic Zone on Venture Capital, 2003, available online.
[109] Id. at art. 5.
[110] Id. at art. 5¶2 and 5¶3.
[111] Id at Chap. 2 sec.1 for the definition of these institutions and Chap. V for the description of promised preferential treatment.
[112] For a friendly overview of the applicable law (as it stands more recently), see Ping Zhang and James Wang, Venture capital investment in China: market and regulatory overview, Global Guide to Venture Capital, 2014, available online.
[113] See Directory on Hong Kong Science and Technology Resources, 2016, available online.
[114] See Report on the Development of the Legal Profession in Qianhai, The Law Society of Hong Kong Working Party on Qianhai Project, November 2012, available online.

Even the regulatory instrument creating the Authority of Qianhai represents a bundle of redundant political goals. The Authority itself cites 15 mandates, likely taken from the regulatory instrument establishing the Authority.[115] At the head of the list, the Authority has the mandate to "organize and develop [*sic*] the development strategy and planning of the Zone."[116] The Qianhai Authority's "major functions" no where mention Hong Kong's participation in the Authority or its activity. The Authority represents a non-profit statutory board which the Shenzhen Municipal Government established. Thus, **the Qianhai Authority has no incentive to make profits or to include Hong Kong into its plans.** Yet, as we pointed out in our literature review, the Qianhai project will likely fail without Hong Kong's significant participation.[117]

The 2018 Hong Kong-Shenzhen Agreement on Qianhai

The Qianhai authorities could avoid such a regulatory mess if they allowed for the direct effect of certain parts of Hong Kong's economic, commercial, and financial law in Qianhai. At least 80% of the stated policies in the documents we have reviewed above address areas where Hong Kong has significantly fewer regulations than Shenzhen. These areas range from business registration to investment fund management. Qianhai even created a separate anti-corruption authority as a clear sign that the zone can not rely on local institutions.[118] The bulk of the Qianhai rules appear to try to make Qianhai regulations and practices more like Hong Kong's. As we showed in the literature review, Hong Kong's rules generally perform better than the Mainland's attempts to mold them in the context of Mainland law. **If Qianhai wants to adopt Hong Kong-like policies, why not just adopt Hong Kong's policies directly?**[119]

The legality of the use of parts of Hong Kong's law relies on several well-established principles and practice in the Hong Kong-Shenzhen area. First, contract law in both jurisdictions allows for the use of foreign law.[120] Thus, in theory, as many firms can use Hong Kong law for their contracts as wanted – with others opting out at will. Second, the raft of trade agreements in the Guangdong region further provide for the recognition of one jurisdiction's standards (like Hong Kong) by the other (like Shenzhen).[121] Many of the agreements we reviewed above provide for either harmonization or mutual recognition – in effect making Hong Kong law applicable in some

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[115] An internet search failed to dig up the instrument establishing the Authority (at least in English). Several references to these unavailable regulations include the *Interim Procedures for Authority of Qianhai Shenzhen-Hong Kong Modern Service Industry Cooperation Zone of Shenzhen Municipality* and the *Implementation Methods for Qianhai's Administrative Review*. We can not provide references to these documents, as we could not find English language versions online.

[116] Qianhai Authority, About Us, 2016, at point 1, available online.

[117] The word "fail" is relative – as such failure would merely likely consist of just another property development project in Shenzhen.

[118] Even before Qianhai becomes operational, its anticorruption agency has found evidence of bribery involving an engineer working on/at the site. See Shenzhen Daily, Qianhai engineer admits to ¥200k in corruption, 25 Nov, 2014, available online.

[119] That is not say that Hong Kong policymakers are immune to such abstract policymaking. Charles Mok's recommendations for promoting innovation are just as abstract as the Mainland governments. See Charles Mok, Promoting Technology, Developing an Innovation-based Economy Recommendations on the Innovation and Technology Bureau, Preliminary Proposal, 2014, available online.

[120] For the specifics of such choice of forum, see Qing-Jiang Kong and Min-fei Hu, The Chinese Practice of Private International Law, 3 Melbourne Journal of International Law, 2002, available online.

[121] For more analysis of the CEPA, see Roger Chan, Hong Kong's Position in Guangdong under "One Country, Two Systems." 24 Seoul Journal of Economics 2, available online.

shape, way or form in Shenzhen/Guangdong. Third, government officials and businesspersons alike can try to rely on legal cooperation agreements between Hong Kong and China. The *Framework Agreement* on Hong Kong/Guangdong Cooperation provides for the "coordination" of law and mechanisms for law enforcement.[122] Fourth, various piece-meal projects already "import" Hong Kong law into Shenzhen. The Co-operation Agreement on the Shenzhen/Hong Kong Innovation Circle Interactive Base, the establishment of liaison offices between the Hong Kong Science Park and the Shenzhen High-tech Industrial Park, and the setting up of a Shenzhen/Hong Kong Productivity Foundation by the Hong Kong Productivity Council basically try to set-up Hong Kong rules and practices in Qianhai. **Allowing for direct effect of some of Hong Kong's laws would be easier than drafting inefficient local versions in/for Qianhai.**

The use of Hong Kong law in both jurisdictions would likely have the same effect as performance-based budgeting. Performance-based budgeting allocates resources for specific policy goals (like increasing the number of new innovations per year by 5% for example). At the Guangdong level, the government has already started implementing performance-based budgets – with limited success.[123] Ironically, the lack of specific policy goals has represented a barrier to the effectiveness of the approach in Guangdong.[124] Econometric evidence furthermore shows that performance-based budgeting saves resources at the province level.[125] At the other extreme, Hong Kong's budgeting system – and legal drafting style in general – focuses more on details and the mechanics of implementation.[126] The high quality of legal drafting in Hong Kong stems (at least in part) from the wide range of training and advisory resources available to Hong Kong's legal drafters.[127] **The merging of Shenzhen and Hong Kong legal drafting styles would thus likely produce performance-based regulation needed for Qianhai's successful operation.** Drafters could easily take the policy objectives from Shenzhen regulations and "attach" Hong Kong's practical regulations and supervision.[128]

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[122] See LegCo Panel on Administration of Justice and Legal Services, Framework Agreement on Hong Kong/Guangdong Co-operation, LC Paper No. CB(2)1580/09-10(01), 2010, available online. As previously mentioned, we could not find the original in English.

[123] For a discussion, see Mei-li Niu, Alfred Ho and Jun Ma, Perormance-Based Budgeting In China: A Case Study of Guangdong, Network of Asia-Pacific Schools and Institutes of Public Administration and Governance (NAPSIPAG) Annual Conference 2005, available online.

[124] "Ironically" because (as we discussed in the previous section), Mainland laws about Qianhai consist of policy goals rather than the delineation of rights and responsibilities typically associated with legal instruments. For more on the weaknesses of the Mainland performance-based budgeting system, see Jun-sheng Li, Performance Budgeting Reform in China, available online.

[125] See Yan-xia Qi and Yaw Mensah, An Empirical Analysis of the Effects of Performance-Based Budgeting on State Government Expenditures, 2012, available online.

[126] Hong Kong academics have discussed the possible adoption of performance-based budgeting in select areas of government administration – without much success to date. See F. Yik, W. Lee, K Chan, and W Wong, The key issues to the development of a performance-based building energy code for Hong Kong, 9 Transactions Hong Kong Institution of Engineers 3, 2002, available online.

[127] See Law Drafting Division Department of Justice, Drafting Legislation in Hong Kong: A Guide to Styles and Practices, 2012, available online. For a more personal description of such drafting in Hong Kong, see Tony Yen, Bi-lingual Drafting in Hong Kong, CALC conference in Hong Kong, 2009, available online.

[128] Such a format would keep the one country, two systems arrangement in place while still promoting legal harmonisation in both jurisdictions.

What about regulations which can not be unilaterally adopted by Qianhai? For example, anticorruption measures governing the ICAC can not apply in Qianhai (and the ICAC can not investigate in the region).[129] In that case, both Hong Kong's and Shenzhen's authorities would be able to "approximate" the relevant laws – as they are already trying to do on the Qianhai side only. Such approximation consists of drafting rules which implement Qianhai-related provisions, while still fitting into domestic rulemaking. Legal practitioners in both systems have significant experience in drafting such approximations of foreign law for domestic use.[130] Figure 23 shows an example of the legal instrument into which policymakers on both sides of the border can place such provisions. In all likelihood the existing rules governing legal cooperation around Qianhai can be moved into this piece of quasi-legislation.[131] **Yet, except as noted below, the direct effect of Hong Kong's law would remove the need for Shenzhen's byzantine Qianhai-related regulations, without creating the need for much more legal drafting.**

Figure 36: Major Provisions of a "Optimal" Qianhai Agreement*

Chapter 1: Direct effect of Selected Hong Kong law
Outlines the provisions (in detailed list form) the provisions from Hong Kong's commercially-related law applicable in Qianhai as well as any restrictions or limitations. Restrictions should be kept to a minimum.

Chapter 2: Approximation and Qianhai Administrative Law
Describes specifically (in detail without abstract principles) how authorities in Hong Kong and Shenzhen will redraft local ordinances (regulations) in areas where Hong Kong commercial law can not apply directly.

Chapter 3: Privatisation (or Regulations for) the Qianhai Authority**
Describes the method of privatisation, interim measures and areas where government still regulates the Authority (in case for political reasons the Authority becomes a regulated body/ QUANGO). As an Appendix, experts may attach a pro-forma business plan for the Authority. In case privatization proves completely impossible, this section might provide for performance-based regulations and a clear delineation of the Authority's competencies and sources of revenue.

Chapter 4: Innovation-Exemptions for GEM Connect Hong Kong-Shenzhen
Numerous scholarly works have identified areas of excessive regulation of start-ups and innovative companies in Hong Kong. These provisions would work like the JOBS Act in the US, fixing the existing problems of the current Connect scheme before implementing with Shenzhen. Light regulation of assets sold through the Connect platform may make venture capital easier to get. Disclosure requirements will help ensure the freedom of information necessary to operate a disclosure-based market.

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[129] Though scholars have started questioning that assumption as well. See Bryane Michael, Can the Hong Kong ICAC Help Reduce Corruption on the Mainland?, Chinese Journal of Comparative Law, 2014, available online.
[130] Albeit governments adapt such approximation for international treaties and norms rather than to implement the rules of a partner jurisdiction. For an example and discussion in the Chinese context, see Sebastian Heilmann and Nicole Schulte-Kulkmann, The Limits of Policy Diffusion: Introducing International Norms of Anti-Money Laundering into China's Legal System, 24 Governance 4, 2011, available online.
[131] Legal cooperation related to Qianhai relates to opening professional services markets in both jurisdictions to each other's lawyers as well as to drafting laws after considering the laws in place in the other jurisdiction. We do not discuss cooperation on the free movement of lawyerly practice in the Qianhai region.

Figure 36: Major Provisions in a Qianhai Agreement (continued)

Chapter 5: Dispute Resolution and Quasi-Judicial Review
Provisions allowing businesspersons in Qianhai recourse to Hong Kong's courts (as a substitute for the Mainland's current inefficient court system). These provisions might also allow for the review of Qianhai-related lawmaking and administrative decisions in Qianhai as well as in Hong Kong.

Chapter 6: Performance-Based Measures for Qianhai (and Hong Kong) Innovation Bureaux
As discussed in the main paper, lack of profit motive crimples innovation agencies on both sides of the borer. This chapter could link Qianhai's performance targets with those of innovation agencies in Hong Kong and Shenzhen. In case of continued public funding and refusal to accept profits as a target, the chapter could also require that innovation-promotion entities generate more tax revenue than they cost – or else scale back.

Chapter 7: Work Plan for Annex 6 of the CEPA (Trade and Investment Facilitation)
The current annex states many laudable and abstract ideals. The revisions should take into account specific cooperation on Qianhai (and other projects).

* "optimal" refers to provisions which maximise the likely profits coming from Qianhai, irregardless of the political acceptability of these provisions. We ignore the likely or realistic likely outcome of such lawmaking in order to focus on our question about the optimal Qianhai design.

** As we discuss in the main text, the first-best solution for ensuring the Qianhai Authority's profit-focused impact consists of privatising it. As government administrators with an interest in the Authority would resist such privatization, the second-best outcome might consist of adopting more specific, concrete regulations governing the Authority's action.

Other legal provisions could help ensure the Qianhai Authority actually promotes innovation. We discuss the privatisation of the Authority in the next section. We do not discuss expanding the Connect scheme to Shenzhen because of significant work already underway on the scheme.[132] The law would not set up the Connect system. Instead, the optimal provisions from the Qianhai Agreement would contain exemptions from reporting, disclosure and other requirements for start-ups seeking to raise capital.[133] We would not discuss in more detail chapter 5, as significant

[132] Most of the available information about the Scheme consists of journalistic reporting. Kasyan provides one of the few academic studies so far of the Connect scheme. See Enoch Yiu, International investors welcome Shenzhen and Hong Kong connect, South China Morning Post, 24 March, 2016, available online. See also Ravi Kashyap, Hong Kong-Shanghai Connect/Hong Kong-Beijing Disconnect (?), Scaling the Great Wall of Chinese Securities Trading Costs, available at: http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2614844

[133] Michael et al. provide a detailed list of potential changes, along with proposed text for new legal drafts. See Bryane Michael, Simon Zhao and Dariusz Wojick, What Role Can an International Financial Centre's Law Play in the Development of a Sunrise Industry? The Case of Hong Kong and Solar Powered Investments, University of Hong Kong Faculty of Law Research Paper No. 2014/034, available online.

effort already exists on facilitating arbitration, conflict resolution in the Qianhai region.[134] Even before talking about extending judicial review to Qianhai, such review of administrative law remains a sensitive issue in Hong Kong itself.[135] Chapter 7 (on cooperation for trade and investment) represents the only other part of the instrument worth expanding on. The terms guiding/governing Hong Kong/Mainland cooperation on investment come from Annex 6 of the Closer Economic Partnership Arrangement (CEPA) and other agreements.[136] As previously noted, these agreements represent general statements of goals and principles. To take one example, article 3.2.1 requires parties to "notify and publicize their respective policies and regulations on external trade and foreign investment promotion, with a view to achieving information sharing."[137] **Subsidiary publicly available work plans and regulations would help ensure that government officials implement the abstract principles contained in regional agreements in order to help companies innovate more profitably.**[138]

Privatizing the Qianhai Authority

Many countries have found decided to promote innovation through passing laws which define government's role in promoting such innovation. India's 2012 Universities for Research and Innovation Bill envisions the express creation of universities for research and innovation (as opposed to just teaching), the protection of intellectual property rights, and the delegation of authority to the university for self-governance.[139] In Sweden, the Research and Innovation Bill proposes to provide incentives for universities to profit directly from the commercialization of research.[140] The Spanish law micro-manages innovation – describing in details how various executive agencies should act.[141]

Hong Kong has neither strategy nor a functioning innovation committee (yet). The new Innovation and Technology Bureau's website remains vacant – and most of its competencies involve "coordinating" or "studying."[142] Any proto-strategy revolves around how the innovation

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[134] Cheung and co-authors provide a discussion of such arrangements; while Fei talks about the enforcement of these agreements. See Esther Cheung, Albert Chan, Patrick Lam, Daniel Chan, Yong-jian Ke, A comparative study of critical success factors for public private partnerships (PPP) between Mainland China and the Hong Kong Special Administrative Region, 30 Facilities 13/14, 2012, available online. See also Lan-fang Fei, Enforcement of Arbitral Awards between Hong Kong and Mainland China: A Successful Model?, 8 Chinese Journal of International Law 3, 2009, available online.

[135] We want to provide the reader with a discussion of judicial review in practice (rather than in theory). As such, in the specific context of reviewing pollution-related regulation, see Price and Ho outline the problems of judicial review in Hong Kong. See Rohan Price and John Ho, Air Pollution in Hong Kong: The Failure of Judicial Review and the Slight Promise of Recent Cases, 2011 Singapore Journal of Legal Studies 2, 2011).

[136] See Mainland and Hong Kong Closer Economic Partnership Arrangement (CEPA), Annex 6 : Trade and Investment Facilitation, 2003, available online.

[137] Id at p. 2.

[138] We provide an example – in the form of a Gaant chart – later in this section to illustrate the concrete nature of these work programmes.

[139] Lok Sabna (Indian Parliament), The Universities for Research and Innovation Bill, Bill No. 61 of 2012, available online.

[140] Swedish Parliament, Research and Innovation Bill, 2012, available online.

[141] See Science, Technology and Innovation Law, Law 14/2011, 1 June, 2011, available online.

[142] For the Bureau's background and place in the government apparatus, see Legislative Council Panel on Commerce and Industry, Proposal to Establish the Innovation and Technology Bureau, LC Paper CB(1)1236/13-14(07), 2014, available online.

and technology committee and bureau will function.[143] Government only recently accepted the lackluster performance of the Innovation and Technology Fund, coming up with reform proposals to make the Fund more responsive to market forces.[144] A recent government audit of the Hong Kong Applied Science and Technology Research Institute Company Limited also – while noting the lack of achievement -- encouraged the Company to use more results-based measures to gauge future performance.[145] Academics like Sharif have called Hong Kong's innovation policy a "rhetorical resource...[whereby] policy makers transform scholarly work and scientific discovery into rhetorical instruments in support of a political agenda."[146] Even in Shenzhen, some attempts at channelling resources into strategic sectors has failed – calling into question (as usual) government's ability to conduct successful industrial policy.[147]
Hong Kong has neither an overall research and innovation strategy nor a legislative instrument (ordinance) which can help coordinate government and private sector innovation.[148]

The design of the Qianhai Authority must provide high-powered profit-motivated incentives to workers in the Authority and outside. The Hong Kong Science and Technology Parks Corporation provides an example of how NOT to model Qianhai. Like Qianhai, these parks basically represent a property development – with scientific equipment and networking sites in a pleasant environment (see Figure 29). The Parks lost money last year (and only made $68 million on roughly $730 million in revenue).[149] Of that amount, exactly 97% of its revenue came from property-related transactions (rental fees, land premia and property management fees). At the same time, 47% of its expenses consisted of administrative/operating expenses and marketing.[150] Numerous commentators have seen the parks in the past as "white elephants."[151] **Such an experience suggests that if Qianhai remains a glorified property development, the area risks reputational damage similar to that of Hong Kong's own previous developments.**

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[143] For initial thinking on the Bureau's main activities, see Legislative Council Panel on Information Technology and Broadcasting Panel on Commerce and Industry, The work of the Innovation and Technology Bureau, LC Paper CB(4)315/15-16(01), 2015, available online.
[144] See Legislative Council Panel on Commerce and Industry, Comprehensive Review of the Innovation and Technology Fund Proposed Improvement Measures, LC Paper CB(1)885/13-14(03),2014
[145] Audit Commission, Administration of Hong Kong Applied Science and Technology Research Institute Company Limited, 2007, available online.
[146] See Naubahar Sharif, Rhetoric of Innovation Policy Making in Hong Kong Using the Innovation Systems Conceptual Approach, 35 Science Technology Human Values 3, 2010, available online.
[147] See Chun Yang, Government policy change and evolution of regional innovation systems in China: evidence from strategic emerging industries in Shenzhen, 33 Environmental Planning C Government Policy 3, 2015, available online.
[148] Hong Kong does have strategies in particular policy areas (like infrastructure). However, the government has not adopted a broad strategic policy aimed at boosting the profits derived from (and thus investment in) innovative goods and services. See Legislative Council Panel on Commerce and Industry, Promotion of Innovation and Technology in Hong Kong, LC Paper No. CB(1)1790/11-12(03), 2012, available online.
[149] HKSTP, HKSTP Annual Report 2014/2015, 2015, available online.
[150] Id at p. 117.
[151] See Charley Lanyon, Hong Kong's white elephants? Jury still out on Cyberport and Science Park, SCMP 22 July, 2014, available online. Given their performance, work has already started on repurposing land for these parks. See also Jake Van Der Kamp, Housing - not science - is the best use of land at Science Park's fourth phase, 9 September, 2014, available online.

Figure 37: Hong Kong's Non-Governmental Governmental Science Parks

The Hong Kong Science and Technology Parks Corporation Ordinance ordained the creation of several of Hong Kong's science parks. The Corporation – much like the Qianhai Authority – is supposed to be independent.* Yet, legislation created the Corporation – and governs its function with a bespoke, custom-made ordinance. Article 31 of the Ordinance carefully defines its rights for the preservation of secrecy. The Financial Secretary must approve in writing investment plans (art. 19) and may give it instructions at will (art. 8.3(b). Like any governmental body, the Corporation must report to the LegCo (art.24) and pays no tax (art. 25). Nowhere in the Ordinance does the Corporation need to make a profit**. Lack of a profit motive sends a horrible message to Hong Kong's innovative companies – saying "you need to make a profit, but don't me to the same standard." The Qianhai Authority clearly follows this ineffective model.

If other countries' experience serves as a guide, Qianhai should operate more like an investment management company than an amorphous incubator. Studies from scholars like Tamasy find that public funding significantly blunts the profit motive of science and technology park managers.[154] Authors like Lofsten & Lindelof as well as Townsend *et al*. have shown that innovation parks fail to deliver faster growth in profits in a range of settings.[155] Even though science parks might produce "spill-overs" from one firm to the next, little evidence supports the view that these spillovers result in sustainable profitability.[156] Authors like Wong *et al*. cite Singapore's TEMASEK as a model for incubating innovation.[157] TEMASEK invests funds with an eye on profit –as 12% of Singapore's GDP resulted from TEMASEK investments at the turn of the millennium.[158] If TEMASEK eventually fails, such failure would likely occur due to the perverse incentives resulting from its past successes.[159] Why can't Qianhai operate much like TEMASEK – with far less government participation than its Singapore peer? Unlike the sovereign wealth fund, Qianhai's initial capitalisation could/would come from investors – with a minority government share. **The Qianhai Authority should be corporatized, privatised (with**

* Sec. 3(3) provides that "Corporation is neither a servant nor an agent of the Government and it does not enjoy any status, immunity or privilege of the Government."

** Art. 6 lists the purposes of the Corporation. The generation of profits does not figure among these purposes.

[154] See Christine Tamasy, Rethinking Technology-Oriented Business Incubators: Developing a Robust Policy Instrument for Entrepreneurship, Innovation, and Regional Development?, 38 Growth and Change 3, 2007, available online.

[155] For the Swedish experience, see Hans Lofsten and Peter Lindelof, R&D networks and product innovation patterns—academic and non-academic new technology-based firms on Science Parks, 25 Technovation 9, 2005, available online. For a global overview, see Anthony Townsend, Alex Soojung-Kim Pang, and Rick Weddle, Future Knowledge Ecosystems: The Next Twenty Years of Technology-Led Economic Development, IFTF Report Number SR-12361, 2009, available online.

[156] See Mariagrazia Squicciarini, Science parks: seedbeds of innovation? A duration analysis of firms' patenting activity, 32 Small Business Economics 2, 2007, available online.

[157] See Poh-Kam Wong, Yuen-Ping Ho, Annette Singh, Industrial Cluster Development and Innovation in Singapore, In Akifumi Kuchiki and Masatsuga Tsuji (Eds.), From Agglomeration to Innovation: Upgrading Industrial Clusters in Emerging Economies, 2010, available online.

[158] See Anthony Shome, Singapore's State-Guided Entrepreneurship: A Model for Transitional Economies? 11 New Zealand Journal of Asian Studies 1, 2009, at p. 327, available online.

[159] Carney and Zheng forcefully argue that state-led innovation chokes off more organic start-up growth. See Richard Carney and Loh-Yi Zheng, Institutional (Dis)Incentives to Innovate: An Explanation for Singapore's Innovation Gap, 9 Journal of East Asian Studies 2, 2009, available online.

the possibility of government share ownership and Board positions) and run like a development financial institution.[160]

The Hong Kong government (and private investors) could participate much more easily in a private Qianhai Authority. If the Financial Secretary allocated funds for 10% of Qianhai's expected future discounted profits, perhaps from the Exchange Fund, such holdings might qualify the Hong Kong government for a Board seat. Government ownership should be enough to encourage patient capitalism without blunting profit incentives too much.[161] As early as 2002, the available econometric evidence showed that partial government ownership would likely increase firm profitability – giving government high-powered incentives to make the Qianhai Authority and the companies it invests in work well.[162]

A New Agreement on Industry-Academic Research Cooperation

If regulation is anywhere the handmaiden of innovation, it is in regulating the university-business nexus. Indeed, recent evidence notes that, without supporting regulations, University spin-outs generate far less profit than the spinning out of highly trained, talented employees.[163] Self-regulation by universities, and to a limited extent government regulation, already sets the parameters for university engagement with business.[164] **Without the significant restraints placed on academics to work part-time with industry, Hong Kong would likely produce as much innovation as the New York or London.**[165] Thus, re-regulation likely serves as the best policy instrument for increasing the likely profitability of the university-business collaboration (and we showed in our literature review that this model best exemplifies the Shenzhen region).

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[160] While they are at it, they might as well repeal the Hong Kong Science and Technology Parks Corporation Ordinance and privatize its assets – sending the right signal to the private sector. Real estate developers like Wharf have developed Qianhai-esque projects in the past. As a listed company, Wharf provides private investors the change to study its investment prospects and to share in the profits its good decisions generate.

[161] Arner and colleagues provide an overview of the Exchange Fund and the way these resources could help grow credit and other markets in Hong Kong. See Douglas Arner, Assessing Hong Kong as an International Financial Centre, University of Hong Kong Faculty of Law Research Paper No. 2014/012, 2014, available online.

[162] See Qian Sun, Wilson Tong and Jing Tong, How Does Government Ownership Affect Firm Performance? Evidence from China's Privatization Experience, 29 Journal of Business Finance & Accounting 1-2, 2002, available online.

[163] Recent empirical evidence shows that R&D funding only impacts on innovation in Hong Kong through university education which workers bring to their jobs. See Wan-Hsin Liu, Do active innovation policies matter? : Findings from a survey on the Hong Kong electronics SMEs, Kiel working paper 1445, 2008, available online.

[164] We do not wish to give a comprehensive overview of these regulations (often grouped under conflict of interest rules). For a somewhat dated by still relevant discussion in the creative industries context, see Desmond Hui, Study on the Relationship between Hong Kong's Cultural & Creative Industries and the Pearl River Delta, 2006, available online. For an almost 50 page example of such regulations from the Hong Kong University of Science and Technology, see Faculty Handbook: Policies Relating to Research and Commercialization, Chap. 24, available online.

[165] Mowery provides an outstanding analysis of the issues involved in industry-university collaboration – including data on the performance of such collaboration. See David Mowery, University-industry collaboration and technology transfer in Hong Kong and knowledge-based economic growth, Hong Kong Innovation Project Report No. 1, 2012, available online.

What should regulation of the academic-industry collaboration consist of? Figure 38 shows the possible provisions for an ordinance aimed at maximising Hong Kong's use of Qianhai.[166] The *Agreement on Joint Promotion of Hong Kong/Guangdong Industry-Academia-Research Co-operation* could provide the legal basis for future lawmaking in this area.[167] Indeed, the only use for the raft of agreements between Hong Kong and Shenzhen/Mainland consists of setting the basis for legislating in each jurisdiction.[168] To keep our analysis focused, we discuss proposed chapters 1-3 (leaving 4 and 5 for another paper).

Figure 38: Provisions of an Ordinance for the Hong Kong/Guangdong Industry-Academia-Research Co-operation

The following outline represents provisions potentially implementing the general agreements in the *Agreement on Joint Promotion of Hong Kong/Guangdong Industry-Academia-Research Co-operation*. Because our paper focuses on the "optimal" rules for Qianhai, we do not consider the practicality or political feasibility of adopting such rules.

Chapter 1: Establishment of a Joint Research Vehicle Legal Structure
Flexible structures – like IP management vehicles -- allow university departments or groups to create limited liability entities aimed at generating profit-related innovations.

Chapter 2: Privatising and Flexibilising Existing Innovation Funding
Creating an explicit investment charter, performance criteria, co-risk takers and making it easier to apply for and use funds as conditions change.

Chapter 3: Implementing provisions for the Patent Reform Ordinance
Develop a flexible original grant patenting system, while encouraging compulsory licensing.

Chapter 4: University-Business Collaboration
Businesses get tax break and universities do not need to show it is academic

Chapter 5: Open wires policy
No censorship for Qianhai-located IP addresses

Chapter 6: Reforming the University of Hong Kong Shenzhen Institute of Research and Innovation (SIRI)
The SIRI looks dead. Make it more like the Harvard iLab.

The figure shows several of the potential provisions related to academic research in the Qianhai region. We do not discuss Chapter 4 or 5 in the text -- as even a political consensus (and no academic work) has not been reached on these issues).

[166] As many of the issues tackled in the figure deal with amending existing ordinance law, a regulatory instrument could not completely accommodate the reforms we propose.
[167] Agreement on Joint Promotion of Hong Kong/Guangdong Industry-Academia-Research Co-operation, 2010, available online.
[168] Usually, international agreements have priority in domestic law (especially when implemented with supporting legislation). Thus, these agreements could – when combined with political will – result in a coherent pack of innovation laws centred around Qianhai and focused on Hong Kong and Shenzhen.

The first chapter could deal with the establishment of a joint research vehicle legal structure. The "joint" refers mandatory participation in the organisation by both academic structures/associations and business ones. Authors like Au and White have argued for looser rules around spinning out (or even keeping within the university) corporate structures which commericalise innovations.[169] In other words, a research institute in the University of Hong Kong (for example) could commercialise an innovation (like a new helicopter design) and hold shares in that corporation. The company could thus serve as a future work experience programme for students – in effect giving students work experience and their university education at the same time.[170] Yet, the legal entities allowing for inventors and investors to profit from innovation need not work like a corporate going concern. Academics need not become businessmen – and deal with the minutiae of everyday business.

Hong Kong's authorities could put these joint research vehicles in place by adopting a version of the "intellectual property management vehicles" increasingly used in other jurisdictions. These corporate vehicles, holding IP rights, can allow disparate investors to share in the cost and benefit of even pure (basic) research.[171] Hong Kong could help popularise this form of special purpose vehicle – winning first-mover (or at least second-mover) advantages as the preferred and largest market for these securities.[172] Such securitisation could also help build a constituency of IP owners who would have strong incentives to police IP markets and avoid illegally copying and using IP property.[173] As China remains extremely lax in its enforcement of IP rights, such a market mechanism could thus reduce IP "wrongs" much more effectively than Chinese (or even Hong Kong's) law enforcement agencies.[174] **If Hong Kong had securitised vehicles for trading**

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[169] Au and White describe these arguments in more detail – and talk about the commercialisation of such innovations in Hong Kong in a venture capital setting. See Kevin Au and Steven White, Hong Kong's venture capital system and the commercialization of new technology, Hong Kong Innovation Project Report No. 5, 2009, available online.

[170] Sharif and Baark describe the challenges of adopting such a mindset in the Hong Kong higher education context. Mok describes the importance of such a relaxation of existing rules. See Naubahar Sharif and Erik Baark, The Hong Kong University of Science and Technology: A case study in entrepreneurial university-led knowledge-based economic development. In Poh Wong, Academic Entrepreneurship in Asia: The Role and Impact of Universities in National Innovation Systems, 2011, available online. See also Ka Mok, Questing for Entrepreneurship and Innovation for Enhancing Global Competitiveness in Hong Kong: Academic Reflections, In John Hawkins and Ka Mok, Research, Development and Innovation in Asia Pacific Higher Education, 2015.

[171] For an overview of this quickly developing area of law, see Dov Solomon and Miriam Bitton, Intellectual Property Securitization, 33 Cardozo Arts & Entertainment Law Journal 1, 2015.

[172] Hong Kong already lags in this market. As early as 1999, academics talked about pop hit song writers like David Bowie cashing in on the securitisation of revenue streams attached to his songs. See Jennifer Sylva, Bowie Bonds Sold for Far More Than a Song: The Securitization of Intellectual Property as a Super-Charged Vehicle for High Technology Financing, 15 Santa Clara High Technology Law Journal 1, 1999.

[173] As even retail investors start holding securities which pay IP-related royalties, the widely dispersed nature of such holdings (and the ease of sharing IP benefits) would naturally give financial incentives to these investors to denounce pirating and refrain from pirating themselves. See Robin Feldman, Intellectual Property Wrongs, 18 Stanford Journal of Law, Business & Finance 2, 2013.

[174] Gische – like most – remains pessimistic about the extent and enforcement of the Mainland's IP law. Without recourse to a well-functioning system of law enforcement, IP markets may only rely on self-enforcing rules (namely rules which market participants themselves have incentives to police and follow). See Emily Gische, Repercussions of China's High-Tech Rise: Protection and Enforcement of Intellectual Property Rights in China, 63 Hastings Law Journal 5, 2012.

IP property rights, their value would come – at the low end of the estimates -- to around HK$2.1 trillion.[175]

The second part of the regulation deals with the Innovation and Technology Fund and innovation grants more generally).[176] Shih and Chen note (and as we showed with data previously) that such funding is "short-term-oriented, dispersed and of reactive type focused on the individual programme-specific level."[177] Part of this section would likely outline the conditions under which universities can create research units financed by the private sector and focused on long-term (10 years minimum) research at the sectoral level or for basic research.[178] The previous regulatory structure required applicants for funding to basically get Legislative Council approval – an almost insurmountable hurdle.[179] Current regulations also forbid the type of "pivoting" that Silicon Valley is famous for (namely abandoning the preliminary idea and trying something new).[180] The government disperses funding widely between companies and research bodies – preventing any one from achieving economies of scale in any particular R&D endeavor. **The lack of specific rulemaking about how these funding schemes should work – and the performance targets – lie at the centre of their inefficiency.**[181]

Policymakers can use several methods to get the Innovation and Technology Fund ready to play a larger role in the Qianhai framework. At the very minimum (and if the Government wants to base the Fund in the world of administrative rights and obligations), the Fund (and related funds) should have full internal regulations – including selection criteria and performance targets – online, as well as its administrative rulemaking online.[182] Having a clear legal framework could

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[175] We used the ratio of IP rights valuations to GDP in the US as a benchmark for determining their value in Hong Kong. Yet, we know that the value of financial instruments traded in Hong Kong come to many times the value of Hong Kong's own GDP – suggesting that the value of these IP rights, if like other traded property rights – could come to around HK$8 trillion at the high end (by applying the roughly 40% of the value of IP not to GDP, as the authors of our source study do, but 40% of the value of financial transactions). See IP Creates Jobs for America, Global Intellectual Property Centre, 25 May, 2012, available online.

[176] We do not review the schemes available – in order to limit our already excessively long study. The most relevant – for our purposes – includes the Innovation and Technology Support Programme (ITSP), Guangdong-Hong Kong Technology Cooperation Funding Scheme (TCFS), and the University-Industry Collaboration Programme (UICP).

[177] Chintay Shih and Shin-Horng Chen, On Reform of Hong Kong's Public Research Funding System, Hong Kong Innovation Project Report No. 3, 2009, at p. 17, available online.

[178] Shiih and Chen also note that Hong Kong has no lack of industry-focused research centres which can bring new ideas into the market place. The lack – they say – lies in creating those ideas in the first place. *Id* at p. 24-26.

[179] *Id* at p. 26. Indeed, they give recommendations at the end of their paper which policymakers might want to consider when drafting this section of the regulation.

[180] Even more recent thinking about innovation funding excludes allowing funded organisations from radically changing their focus. See Panel on Commerce and Industry, Injection into the Innovation and Technology Fund, LC Paper No. CB(1)438/14-15(05), 2015, available online.

[181] We could only fund one set of rules governing the Fund – as an addition to the Public Finance Ordinance. Unlike most country's websites, the Innovation and Technology Commission as well as the Fund's page itself provide no links to administrative rulemaking. See Legislative Council, Resolution on the Innovation and Technology Fund, L.N. 175 of 1999, available online.

[182] Rights and obligations lie at the heart of Hong Kong's (and others') administrative law. Having a state-administered system (rather than a market-administered one) necessarily implies governance by rule of law – not rule by market. Moreover, the Fund has a selection framework – though it consists of tables made in Microsoft Word. These tables hardly provide a reasonable assessment criteria upon which an aggravated party might launch a complaint. For more on the jurisprudential principles governing Hong Kong's administrative law, see Swati Jhaveri,

even help focus staff on outcomes instead of procedural efficiency, as well as help aggravated applicants from Hong Kong and the wider Qianhai area, to appeal decisions currently made in the dark. Yet, more radical reforms would improve the Fund's performance much more.

Partial or full privatisation represents the best possible outcome for Innovation and Technology Fund. The limited econometric evidence available (albeit from outside of Hong Kong) shows that state-run venture funding performs worse than privately funded funding – and even crowds out private funding.[183] Econometric evidence shows comparably poor performance of government-owned and operated venture capital.[184] Treating the Innovation and Technology Fund like any venture capital fund would help ensure the long-term focus of the fund. Even a recent audit report focuses on the Fund's procedures – rather than stepping back and assessing the extent to which the Fund actually generates profitable innovation.[185] As such, even supposedly independent parties (the auditors) have lost sight of the Fund's real and tangible goal (of producing profits rather than paper). Privatizing the Fund would also help it work with the Qianhai Authority. Whether Shenzhen/Mainland centre government authorities privatize the Authority or not, a private Innovation and Technology Fund would be able to contract with the Qianhai Authority as any normal business. Such a privatisation would thus bypass the serious political and administrative obstacles which prevents one part of the Hong Kong government from working with a part of the Shenzhen government. **The government should obviously privatise the Innovation and Technology Fund.**

The third part of the regulation deals with patent reform. Hong Kong has already taken steps to reform its patent system with the 2015 Patent Amendment Bill.[186] The Bill goes nowhere near far enough to ensure Qianhai's dominance as an innovation hub. If companies want to patent inventions, they must still seek patents elsewhere.[187] In other words, Hong Kong subsidises the production of IP with tax incentives – yet does not benefit from this expenditure by creating a fixed "stock" of patents which turns intellectual property into profits.[188] More bizarrely, the Mainland has a functioning original grant patenting system despite having much weaker patent-related property rights.[189] On a scale 12 point scale (with a score of 12 representing jurisdictions

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Michael Ramsden and Anne-Scully Hill, Hong Kong Administrative Law, 2013.

[183] See Dirk Engel and Diana Heger, Differences in Public and Private Venture Capital Companies' Activities: Microeconometric Evidence for Germany, ZEW Working Paper, 2005, available online. See also Fabio Bertoni, Annalisa Croce, and Massimiliano Guerini, The Attractiveness of Private and Public Venture Capital in Supporting the Investments of European Young High-Tech Companies, 2011, available online.

[184] See Jerry Cao, Mark Humphery-Jenner and Jo-Ann Suchard, Government ownership and venture performance: Evidence from China, Presentation at the Australasian Finance and Banking Conference, 2013, available online.

[185] Hong Kong Audit Commission, Chapter 9, Innovation and Technology Fund: Overall management, 2013, available online.

[186] For a background discussion of the issues addressed in the Bill, Commerce and Economic Development Bureau and Intellectual Property Department, Consultation on Review of the Patent System in Hong Kong, 2011, available online. For details about the Bill's first reading, see LegCo, Patents (Amendment) Bill, 2015, available online or online.

[187] For a short and simple description, see Kenny Wong, Is patent reform in Hong Kong on the Horizon? Intellectual Property Magazine, 2012, available online.

[188] We do not discuss these tax incentives, in order to keep this already long paper from growing too long. See Samuel Chan, New Tax Relief in Hong Kong for Intellectual Property Rights - Opportunities and Threats, 38 International Tax Journal 2, 2012, available online.

[189] For more details see W. Lesser, Measuring Intellectual Property strength and Effects: An Assessment of Patent Scoring Systems and Casuality, 4 Journal of Business Entrepreneurship and Law 345, 2011.

with the strongest patent rights), Hong Kong scores a 8.1 – compared with the Mainland's 6.2.[190] The strength of China's property rights put its patent protection on par with Botswana, Colombia, and Romania![191] Thus, **the Mainland has more to gain by Hong Kong developing a globally demanded patent system than Hong Kong has in using and harmonizing with the Mainland patenting system.**

The other part of this chapter – which has not yet received wide discussion – involves defining the mechanics of mutual recognition of patents between China and Hong Kong.[192] So far, mutual recognition remains just an idea – without details provided to the public.[193] The Qianhai parties – namely Hong Kong and the relevant central government authorities – have signed agreements to recognise IP and patent-related (as well as other civil and commercial) court decisions and judgements.[194] We do not show the same analysis shown previously about the Agreement's specificity and likely effectiveness. Needless to say though, without full joint participation in a Qianhai-like arrangement, the Agreement will – like many other agreements – remain a declaration of political ideals. The market for patents will determine Hong Kong's (and thus Qianhai's) demand for patents (and supply of innovative intellectual property) more than any legal agreements.[195] Econometric evidence shows that if Hong Kong can develop a globally competitive and used patent registration regime, Hong Kong (and thus Qianhai) can take a significant amount of patent traffic way from the established centres.[196] **Qianhai can only succeed when Hong Kong patents become substitutes for EU, US and Mainland patents**.

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[190] The author constructed this index by using a statistical procedure known as "factor analysis" on four factors related to the strength of patent rights and systems. For the exact description of the index and its construction, see Id. at p.357.

[191] Id at p. 359-360.

[192] The government, at the time of this writing, is working on some of the regulations. In theory, this section of the regulation could deal with other issues – like the authorisation to hold oneself out as a patent advisor or to define the state of IP litigation in Hong Kong. We do not discuss these minor issues – to keep our discussion focused on the largest and most relevant issues for our research. For a discussion of the litigation issue, see Douglas Clark, Intellectual Property Litigation in Hong Kong: Are the Courts up to the Challenge? Hong Kong Lawyer, June, 2014, available online.

[193] For more, see Legislative Council Panel on Commerce and Industry, Updated background brief on review of the patent system in Hong Kong, LC Paper No. CB(1)743/14-15(04), 2015, available online. See also Report of the Advisory Committee, available online.

[194] See Arrangement on Reciprocal Recognition and Enforcement of Judgments in Civil and Commercial Matters by the Courts of the Mainland and of the Hong Kong Special Administrative Region Pursuant to Choice of Court Agreements between Parties Concerned, 2006, available online. For the Mainland's guidance interpretation, see Interpretation by the Supreme People's Court on the Arrangement on Reciprocal Recognition and Enforcement of Judgments in Civil and Commercial Matters by the Courts of the Mainland and of the Hong Kong Special Administrative Region Pursuant to Choice of Court Agreements between Parties Concerned (Adopted at the 1390th Meeting of the Judicial Committee of the Supreme People's Court on 12 June 2006) Judicial Interpretation No. 9 of [2008] Time of Promulgation: 06:51:43 04-07-2008, available online.

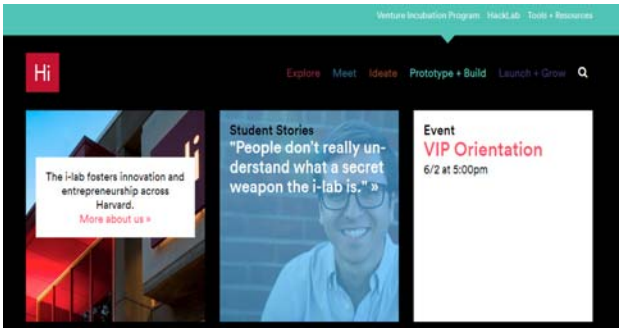
[195] Several studies look at the determinants for patent demand geographically. "Gravity" (namely the size of markets and the popularity of a patent registration centre) explains demand for patents from particular jurisdictions far more than the existence of legal agreements. See Giuditta De Prato and Daniel Nepelski, Institute for Prospective Technological Studies, International patenting strategies in ICT, EU Commission Report EUR 25965 EN, 2013, available online. See also Carlo Menon, Stars and Comets: An Exploration of the Patent Universe, SERC Discussion Paper 37,2009, available online.

[196] Naturally, much patent demand derives from the need to establish patents in different jurisdictions. Namely, even if a firm has a US patent, they may wish to file patents in the EU, Japan and so forth in order to solidify protection claims in court. Hong Kong will always have such demand. Yet, by serving as a jurisdiction-of-choice in a future global system based on the mutual recognition of patent claims, Hong Kong can build up its lead now. For evidence

Chapter 6 of the proposed innovation ordinance represents the easiest part of such rulemaking. Many of the supposed collaborative efforts aimed at promoting innovation in the Qianhai region remain underdeveloped. The University of Hong Kong's Shenzhen Institute of Research and Innovation (SIRI) provides one of the most obvious examples of such work.[197] The Institute received its funding from Shenzhen Municipal Government – an administrative body which can give or not give funding at will.[198] Like the results page of the Hong Kong government's Technology and Innovation Fund, the website reports the number of projects funded – rather than the actual change in profits or marketable ideas.[199] Unlike Harvard's iLab, the Institute only seeks government funding – involving few private sector participants. In contrast, as shown in Figure 29, the iLab focuses on concrete stories, with plenty of opportunities for anyone to participate in activities like its Venture Incubation Program.[200] One the closest equivalents, the Hong Kong government funded Impact Incubator, represents a poverty alleviation scheme more than a profit-driven program aimed at commercializing innovation.[201] **As such, programmes like the SIRI represent missed opportunities for bringing real, actual marketable innovation into the Qianhai region.**

Figure 39: The iLab is Everything SIRI is Not

The SIRI represents a PR platform for letting people know about large-scale research.



Harvard's iLab lets anyone participate in innovation, bringing together money and ideas

How can rulemaking help reform academic units like the SIRI? First, government should focus on enabling entrepreneurs and innovations (using platforms like a copy of the iLab) rather than trying to run its own innovation development programmes.[202] Second, universities like the University of Hong Kong can put their rules for industry-academic collaboration online, so outsiders as well as staff and students can know the limits of their work with the private sector.

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on the effect of patent fees on patent demand, see Gaetan de Rassenfosse and Bruno van Pottelsberghe de la Potterie, On the price Elasticity of Demand for Patents, ECARES working paper 31, 2008, available online.

[197] See Shenzhen Institute of Research and Innovation, Introduction, 2016, available online.

[198] Id at line 2.

[199] The available funding results (only available in Chinese) consist of a table with one row for 2014 and 3 rows for 2013. See Id at Research Funding, 2016, available online.

[200] See Harvard iLab, Venture Incubation Program, 2016, available online.

[201] See Impact Incubator, 2016, available online.

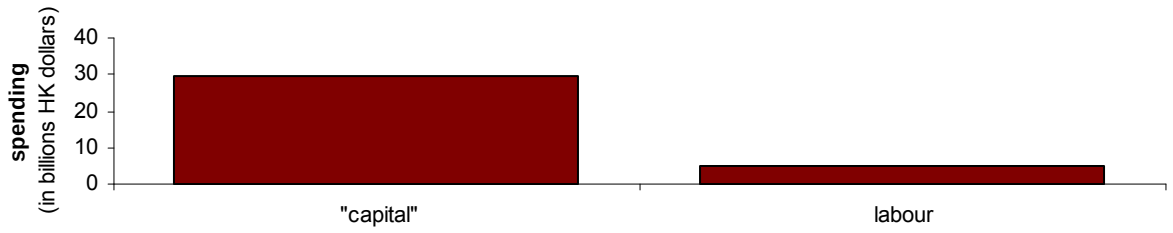
[202] The minutes from a recent Commission on Strategic Development clearly illustrates the government mindset. Instead of talking about how government has helped specific companies, the minutes only review work of various government institutions and programmes (like the Commission on Technology and Innovation, the Technology and Innovation Fund and so forth). See Summary of Views Expressed at the Fourth Meeting of the Commission on Strategic Development held on 26 November 2015, 2016, available online.

Like the SIRI, the Knowledge Exchange website looks more like an advertisement than a place to bring inventors and investors together.[203] Third, the Bureau (or Commission) for Education can issue clear regulations about how universities can engage with business.[204] Working on the principle of positive administrative silence, these short regulations would allow everything not explicitly forbidden under the regulations.[205] **Allowing for positive administrative silence and light regulation in the ordinance we propose would put industry-university collaboration on a square footing**.

Costing of the Development Plan

How much would the Qianhai project actually cost? By establishing these costs, we can see if the Qianhai plans are realistic and what kind of contribution the Hong Kong government should make. Figure 40 shows expenditure on the roughly 30 distinct objectives given by the Shenzhen Authority.[206] Readers interested in more details can see the relevant Appendix. Unsurprisingly, capital expenditure makes up a large share of the total – given the amount of real estate the development will create. Adding up all these costs gives a total cost of around HK$35 billion. **If Hong Kong really wants to take an equal state as the Mainland in Qianhai's success, special administration region's government would need to shell out about HK$18 billion.**

Figure 40: Qianhai's Implementation Costs about HK$35 billion



The figure shows the estimated spending needed to implement Qianhai's objectives. We have divided such spending into wage payments and "capital" (which contains all non-wage spending on machinery, real estate, etc.) over a two "work-year" period. See main text and Appendix for more information.
Source: based on policy objectives from Qianhai Authority (2016).

Yet, as we describe in the next section, showering Qianhai-related projects with money will not raise innovation-led profits half as much as policy reform. We give four main reasons in the next section, which we summarise here. First, by improving the profit impact of each dollar of R&D,

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[203] University of Hong Kong Knowledge Exchange Office, 2016, available online.
[204] The Bureau of Education website is hard to nagivate and its "policy documents" section only contains copies of international agreements and information on various scholarships and study schemes. The Education Commission's website seems to contain working group information on education reform only up to 2006. See Education Bueau, Education System and Policy > Post-Secondary Education > Policy Documents, 2016, available online. See also Education Commission, Working Groups, 2016, available online.
[205] Anthony describes the evolution of the concept in the UK, underpinning how administrative silence allows bodies like universities to engage in activities which a more regulated system would probably not allow. See Gordon Anthony, Administrative Silence and UK Public Law, 2016, available online.
[206] See China (Guangdong) Pilot Free Trade Zone, Qianhai & Shekou Area of Shenzhen, 2016, available online.

fewer (not more) dollars can go toward generating more profits.[207] Second, multiplier effects and feedback loops between profits, R&D and investment/cash available increases the effect of adding resources. The "innovation system" then increases the impact of changes in R&D spending well beyond the effects such R&D would have in isolation.[208] Systemic reform must fix problems which keep markets for profitable innovation (and R&D) from settling to equilibrium at their socially optimal point.[209] R&D produces social goods like commercially valuable tacit and codified knowledge – which can help more than just the company producing such knowledge. **Government's role should not consist of giving away money, but in structural reform which makes it more profitable for companies to engage in large-scale, long-term R&D in the first place.**[210]

If the Qianhai Authority should reallocate resources away from its plans and towards "structural change," what activities should the Authority fund? Figure 41 shows some of the ways that the Qianhai Authority can increase the innovation-led profitability of companies in the Qianhai region. First, as we previously showed, both the Hong Kong and Shenzhen government spend large amounts of money on subsidizing start-ups, R&D and other supposedly innovative activity. Thus we repeat that government should not give money away.[211] Second, spending money to police and discourage collusion, abuse of market power, and closed markets would like generate more profits over the longer-run.[212] As companies in the Qianhai region innovate to survive, these innovations can led to sustained competitive advantage globally.[213] Third, tax incentives

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[207] Authors like Sun and coauthors might describe such an increase in the resource efficiency of R&D to generate profits as a "innovation competence." In our own model, it simply represents the exponential effect that reform has on R&D as a driver of profits. See Hong-yi Sun, Shui-Yee Wong, Yang-yang Zhao, Richard Yam, A systematic model for assessing innovation competence of Hong Kong/China manufacturing companies: A case study, 29 Journal of Engineering and Technology Management 4, 2012, available online.

[208] Fu presents econometric evidence showing how such a systemic approach – adopted in the UK and increasingly in China – promotes profitable innovation by taking a "dual role" (educational and commercial). See Xiao-lan Fu, China's Path to Innovation, Chapter 8: The Dual Role of Universities in Industrial Innovation: Comarping China and the UK, at 201, 2015.

[209] Nuno describes and quantifies the extent of such a mismatch between the amount of R&D spending which maximises individual firm's profits and the amount of R&D spending which maximises all firms' profits. Yet, as we argue – and in complete disagreement with authors like Grossman and coauthors – that government must not subsidize R&D. See Galo Nuno, Optimal Research and Development Expenditure: A General Equilibrium Approach, Bank of Spain Working Paper 1009, 2010, available online. See also Volker Grossmann, Thomas Steger, Timo Trimborn, Dynamically Optimal R&D Subsidization, University of Freiburg Working Paper, 2010, available online.

[210] As we proof in the Appendix, changes in our model's structural parameters has a larger impact on profits than changes in the levels of the variables themselves.

[211] See Scott Wallsten, The Effects of Government-Industry R&D Programs on Private R&D: The Case of the Small Business Innovation Research Program, 31 RAND Journal of Economics 1, 2000, available online.

[212] The World Bank, for example, argues that increased competition implies market access and openness – providing comfort to foreign investors looking to fund innovation and R&D in Chinese companies. Without such openness, they fear expropriation. See Chinese Development Research Center of the State Council and World Bank, China's Growth through Technological Convergence and Innovation, In China 2030: Building a Modern, Harmonious, and Creative Society, 2013, available online.

[213] Toyota remains one of the best examples of a company innovating to survive. Toyota needed to develop "flexible specialisation" as a response to the US car manufacturers economies of scale and first-mover advantages. Aghion and coauthors provide a more rigourous (less descriptive) description of the link between competition and innovation. See Meine van Dijk, Flexible Specialisation, the New Competition and Industrial Districts, 17 Small Business Economics, 1995, available online. See also Philippe Aghion, Stefan Bechtold, Lea Cassar, and Holger Herz, The Causal Effects of Competition on Innovatioon: Experiment Evidence. Harvard University Department of Economics Working Paper, 2014, available online.

can encourage R&D. Yet, current incentives do not affect the marginal incentive to innovate – only the cost to locate a particular type of company in Qianhai.[214] The more innovations these companies can produce, the more likely they will profitably insert themselves in various global value chains.[215]

Figure 41: A First Look at Costing Optimal Qianhai Spending

The Qianhai Authority will increase profits-led innovation by improving the way that companies make and use their profits. Simply subsidizing work spaces or researchers will have a much shallower impact.

1. Avoid grants. As we showed in the literature review – and as authors like Wallsten show – governemnt grants likely just crowd out private spending. Government should not subsidize companies' R&D.

2. Open markets to competition. Despite a new competition law, oligopolistic producers continue to provide goods and services (building, supermarkets and so forth). On the Shenzhen side, capital controls prevent Chinese money from investing in innovative companies abroad (and taking back what they learn). These controls also prevent these companies learning from the investment of Hong Kong and foreign companies.

3. Encourage shotgun innovation with tax deductions. Chinese innovation represents a threat to Western companies because its companies' ability to test many variants on an idea in parallel. Such massive trial-and-error methods result in predictable serendipity. Companies would engage in more of such spending if such spending helped lower their tax bill.

Sources: see main text for references to the evidence for the points presented above.

Why shouldn't Hong Kong simply free-ride on Shenzhen's spending? In other words, why doesn't Hong Kong simply wait for the Shenzhen municipal government and central government to finish setting up Qianhai, and then benefit from the extra trade and innovation the zone creates? As we have noted already, most academics studying the region see a fundamental difference between Hong Kong's and Shenzhen's (Mainland) policies which would make the functioning of a Qianhai cooperation zone impossible.[216] We agree. Without a significant stake in Qianhai's success, the Hong Kong government would have insufficient incentives to cooperate on any Qianhai-related spending. Indeed, if handled correctly, Qianhai could built political support for both governments.[217] Hong Kong has, and should, serve as a link between Shenzhen and the

[214] "Marginal" refers to the addition of an extra unit of R&D spending (or other money). Qianhai companies working in certain sectors receive preferential tax treatment (and we show these industries in an appendix). Yet, these tax incentives to not apply to increasing larger spending on R&D. Only marginal tax rebates can change companies' production and investment decisions.

[215] Clark and colleagues note that Chinese companies already do this. Yet, tax incentives can provide marginal incentives to increase their investment in such innovation. See Normal Clark, Joanna Chataway, Rebecca Hanlin, Dinar Kale, Raphael Kaplinsky, Lois Muraguri, Theo Papaioannou, Peter Robbins, and Watu Wamae, Below the radar: What does innovation in the asian driver economies have to offer other low income economies. Innogen Working Paper 69, 2009, available online.

[216] Tsze-wah Gabriel Chan and Simon X.B. Zhao, Advanced producer services industries in Hong Kong and Shenzhen: Struggles towards integration, 53 Asia Pacific Viewpoint 1, 2012, available online.

[217] Some academics have argued that projects like these aim for mostly at political visibility, rather than actually generating innovation. See Peter Cheung, The politics of regional cooperation in the Greater Pearl River Delta, 53 Asia Pacific Viewpoint 1, 2012, available online.

world.[218] Yet, **without Hong Kong spending to develop that link between the Mainland and the outside world, the other major commercial centres would likely just bypass Hong Kong.**

Getting Hong Kong Ready for Qianhai

The Innovation and Technology Commission operates results-based evaluation system with so simple targets that only a completely incompetent agencies could miss these targets. The Commission has a budget in 2015-15 of HK$620 million for approximately 200 non-directorate posts (for salary expenditure budgeted at around $110 million as well as 8 directorate posts).[219] For these funds, the Commission reports 100% success for 13 objectives as shown in Figure 42. The current government has reassigned two unsuccessful departments from the Commerce and Economic Development Bureau to the new Innovation and Technology Bureau (which serves basically as a secretariat for the IT Commission).[220] Such a reassignment thus hides these departments from public attention. A recent internal review of the Innovation and Technology Fund (done by the Innovation and Technology Commission itself) unsurprisingly found little wrong with the Fund.[221] After completely ignoring issues like value-for-money or outcomes-on-long-term innovation, the review makes only marginal suggestions about improving the efficiency of the Fund. Similarly, a 2009 review encourages the "promoting development and research" by simply encouraging the government to "facilitate", "form" and otherwise "enhance" various aspects of innovation.[222] As previously described, most of these successes focus on process – rather than on the actual profits which make a centre of innovation sustainable. **Without a shift in focus toward results (like profits, new innovations made, and so forth), Hong Kong will have no leverage to ensure Qianhai's performance.**

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[218] For a description of that relationship, see Simon Xiaobin Zhao , Yingming Chan, Carola B. Ramón-Berjano, Industrial structural changes in Hong Kong, China under one country, two systems framework, 22 Chinese Geographical Science 3, 2012, available online.

[219] Government of Hong Kong, Head 155 — Government Secretariat: Innovation and Technology Commission, 2015, available online.

[220] See Samuel Chan, Hong Kong's new Innovation and Technology Bureau to absorb two departments from commerce bureau: Two departments under the remit of commerce bureau to be reassigned, South China Morning Post, 11 Nov, 2015, available online.

[221] See Innovation and Technology Commission, Comprehensive Review on the Innovation and Technology Fund, LC Paper CB (1)211/14-15(03), 2014, available online.

[222] Legislative Council, Motion on "Promoting Research and Development" Progress Report, 2009, available online.

Figure 42: The Innovation and Technology Commission's Perfect Track Record for Bureaucracy

1. To inform applicants the result of their applications under the University-Industry Collaboration Programme within 30 working days after receipt of full information

2. To inform applicants of the result of their applications under the Internship Programme within 5 working days after receipt of full information.

3. To send out at least 90% of all quotations within 2 working days upon confirmation of calibration requirement (for the Standards and Calibration Laboratory)

4. To complete at least 90% of all calibration jobs within 13 working days upon receipt of customer equipment (for the Standards and Calibration Laboratory).

5. To answer simple technical enquiries within 1 working day upon receipt of the enquiry (for Product Standards Information Bureau),

6. 2. To provide quotation/response on sales of originals or copies of standards within 1 working day upon receipt of the request (for Product Standards Information Bureau),

7. 1. For applications for extension within an existing test category, inspection or certification field, 85% of applicants will receive the assessment report within 60 working days upon receipt of properly completed application and necessary documents (Hong Kong Accreditation Service)

8. 2. For applications for extension within an existing test category, inspection or certification field, 85% of applicants will be granted accreditation within 14 working days from the date that all remedial actions are confirmed to be satisfactory (Hong Kong Accreditation Service).

9. For new applications or applications for extension into a new category, inspection or certification field, 85% of applicants will have the advisory visit conducted within 21 working days upon receipt of properly completed application and necessary documents (Hong Kong Accreditation Service).

10. For new applications or applications for extension into a new category, inspection or certification field, 85% of applicants will receive the assessment report within 76 working days from the date the applicant confirms readiness for formal assessment.

11. For new applications or applications for extension into a new category, inspection or certification field, 85% of applicants will be granted accreditation within 14 working days from the date that all remedial actions are confirmed to be satisfactory.

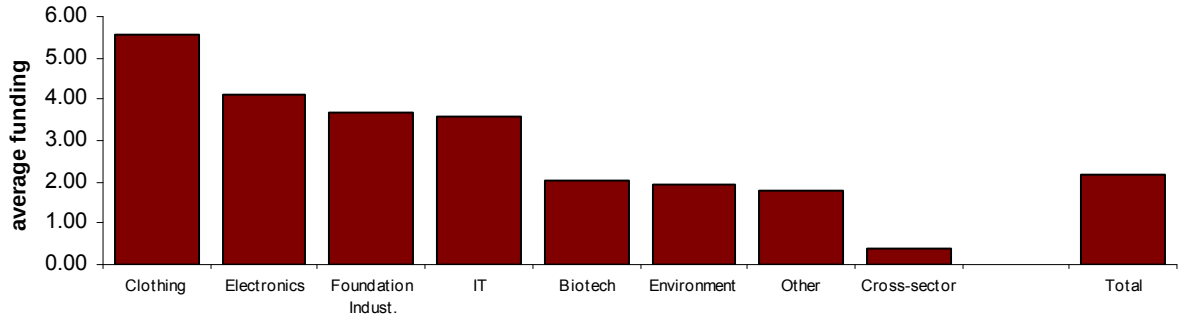
12. To issue an acknowledgement or an interim reply within 10 calendar days upon receiving a complaint

13. To send a full reply to the complainant within 1 month upon receipt of the complaint (or a detailed explanation for complicated cases which cannot be fully addressed within 1 month)

Source: Innovation and Technology Commission (2016).

Once innovation agencies like the Innovation and Technology Fund, the Innovation and Technology Commission and ultimately the Qianhai Authority focus on profits (rather than bureaucracy), funding can be increased.[223] At present, the Innovation and Technology Fund's resources barely represents a drop in the bucket. Figure 43 shows the Fund's distribution of projects for 2016.[224] The most funded sector – clothing – hardly strikes one as a sector of the future. By volume, non-descript "cross-cutting" projects received the most funding – even though their average value remained much smaller than sectoral-specific funding. The average project only received about HK$2 million in funding – a relatively small amount for incubating world-changing technology. Once the Fund (and Commission) have profit-oriented incentives, such funding can expand exponentially – as such funding has in Hong Kong's competing centres (like San Francisco, Berlin, Sweden, Tel Aviv and so forth).[225] Given the exponential nature of the way cities attract venture capital, those cities with a head-start in developing a private market in venture finance will likely pull resources away from less developed centres like Hong Kong.[226] **These centres show that the longer Hong Kong delays privatising its venture support, the less future venture capital its innovative companies will receive.**

Figure 43: How Much Innovation Could YOU generate with only HK$2 million?



The figure shows the average funding for Innovation and Technology Fund Approved Projects by sector. Clothing does not strike one as an innovation leader. Almost 2200 projects (or 45% of projects) fall under the non-descript "cross-cutting" label. Source: Innovation and Technology Commission (2016).

The final element of preparing Hong Kong for Qianhai may include putting in place regulatory instruments that implement the various agreements between Hong Kong, Shenzhen and the

[223] Almost every analyst looking at innovation in Hong Kong wrongly recommends increasing public funding for research and development. Simply adding more money to a dysfunctional system does not generate better outcomes. For a general background, see Chintay Shih, Shin-Horng Chen, Innovation Policy and the Limits of Laissez-faire, In Reform of Hong Kong's Public Research Funding System, 2010.

[224] See Innovation and Technology Commission, Innovation and Technology Fund: Distribution of Approved Projects among Different Industrial Sectors (as at 29/02/2016), 2016, available online.

[225] Many of these agencies work on a public-private network basis – whereby the agency helps bring companies, investors and inventors together – but does not have any large spending or grant-giving power of its own. For a discussion in the French context, see Rabeh Morrar, Faiz Gallouj and Hakim Hammadou, Public-private innovation networks and innovation activities in French service firms, 2 Journal of Innovation Economics & Management 10, 2012, available online.

[226] For evidence and discussion, see Richard Florida and Charlotta Mellander, Rise of the Startup City: The Changing Geography of the Venture Capital Financed Innovation, CESIS Working Paper Series Paper 377, available online.

Mainland central government. As noted, most of these agreements consist of abstract wording focused on "encouraging", "promoting" and "cooperating." These agreements thus lack the precise definition of the rights and obligations usually associated with administrative legal drafting.[227] Evidence suggests that local policies would still have less of an impact than national policies.[228] Yet, given the complexities of dealing with Mainland central authorities, the least-cost, highest benefit approach probably consists of using already existing agreements at the Guangdong level. As previously mentioned, the Hong Kong-Guangdong Cooperation Framework Agreement probably provides the best basis for establishing concrete, specific rules governing any Qianhai cooperation. Amendments to Annex 6 of the CEPA (Chapter 7 dealing with trade and investment Facilitation) could similarly include the specific provisions that the Hong Kong, Shenzhen and central government did not include in the previous round of negotiations.

The Effect of Qianhai Cooperation on Innovation in the Hong Kong-Shenzhen Region

Overview of the model and statistical tests

We choose the simplest possible economic model of innovation for our analysis of Qianhai's expected costs and benefits. As shown in Figure 44, the model revolves exclusively around the accounting statements of the firms' targeted by Qianhai's favoured sectors. The first major variable in our analysis consists of **cash** firms have available for producing, selling and investing in things like R&D. Such cash not only determines each firm's production possibilities, but also measures its success. Profitable firms attract cash – from retained earnings and from investors looking to put money into the enterprise. The amount of **R&D spending** represents the second variable we considered in our analysis. As the Qianhai-related literature discusses the effects of the new region on R&D and thus innovation, we try to determine the likely extent to which having more cash and profits increases such R&D spending. **Profits** represent the most important variable – the thing we actually care most about. As previously mentioned, innovative companies look to increase profits – just like any capitalistic firm. We can guess how company decisions impact on profits by looking at dividends, retained earnings, shareholder returns, and tax payments. Unlike in all other studies, innovative activity for us has no value in itself. **Our model assumes and requires that only profit-oriented innovation produces any benefits for the Qianhai region.**

In order to understand how these variables interact, we need to look at spending on, and financial flows affecting, other parts of the income statement and balance sheet. A number of other variables – like total assets, capital spending, debt levels, employment numbers and other factors described in our study – influence the model's variables. We use other variables – like revenue, common shares outstanding, the amount of debt and other factors – to interpret our model results. We describe how we deal with, and interpret, these variables in Figure 45.

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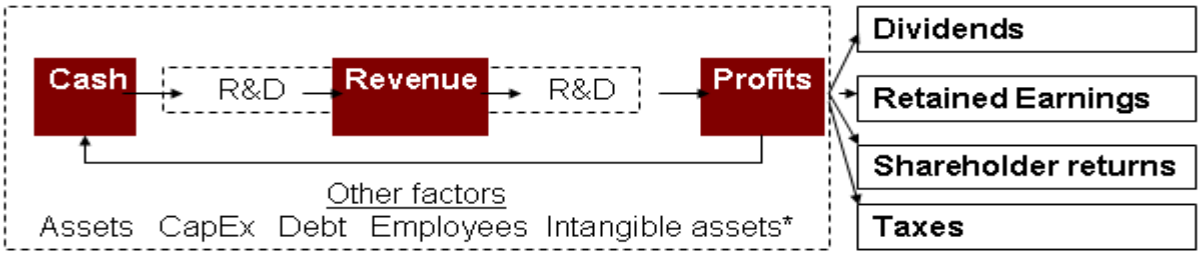
[227] Hong Kong understandably shares the British legal and administrative systems' reliance on administrative discretion and *bon sens* in much of its administrative law (as indeed, "administrative law" in Hong Kong as an academic and applied discipline focuses more on court rulings about executive action more than on the mechanisms and outcomes of resolving previous administrative conflicts. An expert in French or even American administrative law would thus find Hong Kong administrative law relatively underdeveloped.

[228] See Brian Fong, The Partnership between the Chinese Government and Hong Kong's Capitalist Class: Implications for HKSAR Governance, 1997–2012, 217 The China Quarterly, 2014, available online.

Figure 44: Model of "Pure" Effects of R&D Spending in Qianhai



The figure shows the model we test to assess whether more funding would increase R&D spending in the Qianhai region. We look at these effects for Hong Kong and Shenzhen separately, then as an integrated group to assess whether a consolidated Qianhai innovation space would produce more profits than the innovation policies in each city.

Figure 45: Procedures Used at a Glance for Qianhai Study

(layperson's summary of Appendix IV)

What question did you try to answer?

What kinds of resources and changes to the innovation environment would the Qianhai Authority need to make to make Qianhai more attractive than Hong Kong or Shenzhen for companies in the sectors they target.

What variables did you look at?

We modelled profit (proxied by EBITDA or earnings before interest, tax, depreciation and amortization), R&D spending, and "cash" (like current assets). To add depth to our analysis, we peeked at changes in variables like common shares outstanding, retained earnings, intangible assets as others. Looking at these other variables could help confirm our understandings.

What statistical techniques did you use?

We report normal regression results – but relied mostly on cutting-edge methods known as **Method of Moments Panel Regression**. Such a procedure allowed us to use a structural equations approach, using non-linear methods (maximum likelihood estimation), construct instrumental variables which control for some of the chicken-and-egg problems in our model, and deal with wild variances which would invalidate other kinds of regression.

Where did you get your data?

We used Compustat data – which provides balance sheet and income statement data for companies in Hong Kong and Shenzhen. We looked at data from 2009 to 2015 (where available).

How did you control for outside factors?

We controlled for companies' city (as we wanted to see how innovation-led profits differ between the two jurisdictions) and for sub-sector. We also tested for year and company-specific effects (namely stuff happening in a particular year or company that could throw off our results).

What kinds of regression models did you use?

We tested four alternative models of economic behaviour. In the classical model, we looked at the role of labour and capital in determining innovation-led profits. The resource model looked at the role of resources from debt, common stock and other sources as a motor of innovation-led profits. The cash based model looked most at how relaxing financing constraints helped promote profitable innovation. Where useful, we mixed-and-matched variables to see which world view had the best statistical explanatory power.

What did you use your statistical results for?

We used them to develop a test structural model consisting of three equations (for profits, for R&D spending and for "cash"). Our modelling of cash helped us make observations about the need of attracting investment.

Once we developed this structural model (of 7 geometric parameters and 3 linear parameters), we could figure out the costs and benefits of adopting particular policies we discussed in the previous section.

What does "pure" profit, R&D and cash mean?
Figures on a balance sheet naturally correlate heavily on each other. Profit will, by definition go down as firms spend money on R&D because the definition of earnings subtracts out R&D spending. Cash available to a company rises as profits increase because profits are literally defined in cash terms. Procedures like "two-stage least squares" (itself a part of the method of moments framework), we can isolate that part of profit that does NOT depend on R&D spending simply because of the fact that accounting conventions subtract R&D spending from the higher balance sheet lines that feed into a profit line item. "Pure" variables thus have none of the confounding chicken-and-egg problems that make econometrics so difficult.

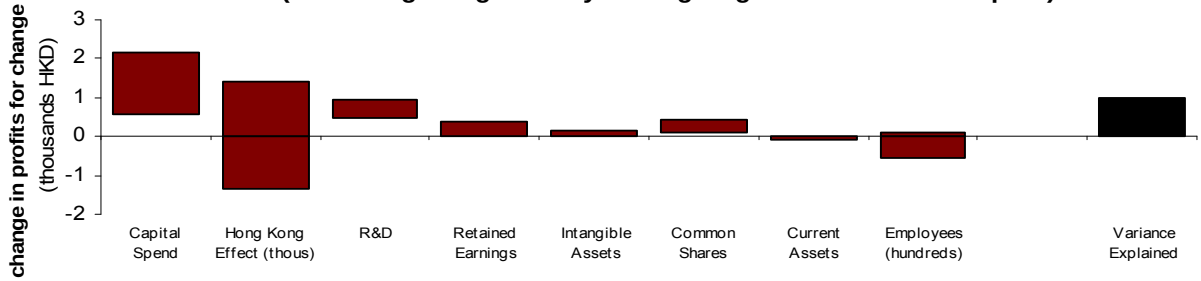
How do you know you are right?
We do lots of common sense checks – and present data about other variables which correlate with our variables (like dividends, income taxes, etc). Too many fools hide behind fancy econometrics and big words. We show many of these results in the large appendices to this study.

What affects our model variables?

What affects the profits of innovation-oriented companies in the Qianhai region? Figure 46 shows the simple-minded regression of various factors on profits. Capital spending had the largest effect on profits – with the estimated effect of changes in capital spending on profits varying between 1 and 2, depending on the model used. Thus, for a HK$1000 change in capex spending, profits of innovation-led companies in Hong Kong and Shenzhen could change by anywhere between HK$1000 to HK$2,000.[229] Retained earnings (a contributor to the cash which funds innovation) increases profit – not surprising as retained earnings come mainly from profits. The number of employees has the expected ambivalent effect. The very "good" explanatory power of the regression (with an adjusted R-squared of around 0.90) in itself tells us little.[230]

[229] We do not continue to put an HK before the dollar sign, to make the text easier to read. Unless we note otherwise, readers can assume that all values presented in this section relate to Hong Kong dollars.
[230] The R-squared refers to the amount of variation in the data that this regression explains. The close relationship between all these variables on the balance sheet/income statement makes such a high R-squared statistic unsurprising. Yet, as one fact among many other contributing facts, the data paint a picture of the close relationships between our model's variables.

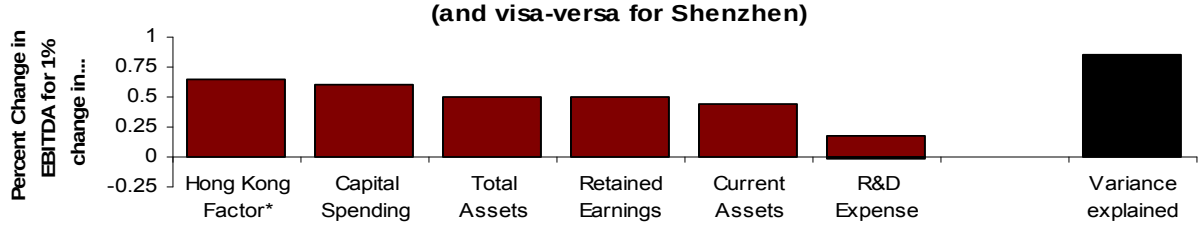
Figure 46: Qianhai Profits Would Rise with More R&D and Resources (with Hong Kong Already Having Negative Returns to Capital)



The figure shows the b-values of regressions of the effect on levels of EBITDA in Hong Kong and Shenzhen for changes in the variables shown. We show the range of b-value estimates over the various models we tested. We provide these data mostly to help build an intuition around the data (though these levels data do not show the same kinds of serious problems usually associated with levels-data). Both capital spending and R&D spending, show an effect on profits -- with "cash" having less certain effects. Yet, the large variance in b-values tells us we need more robust econometric methods.
Source: authors.

Econometric work using growth models – rather than the simple linear model reported above – adds credence to these initial findings. Figure 47 shows the results of similar regression work, this time better targeting the geometric growth in profits, R&D spending and cash. In this better model, a firm's location in Hong Kong best explains its profits – and indeed the wide body of evidence we reviewed in the literature section of this study points to the role of Hong Kong law and custom in raising profits. Again, capital spending better correlates with profits than R&D spending. Larger companies tend to have larger relative profits. Indeed, if we can believe these data – a 10% increase in an innovation-oriented company's total assets correlates with a 5% increase in EBITDA (our proxy for profits). This model uses the natural log values of the variables shown – a way of capturing the effects of geometric growth. Such a model continues to perform excellently in explaining the variation in our data.

Figure 47: Hong Kong Needs Money More than R&D (and visa-versa for Shenzhen)

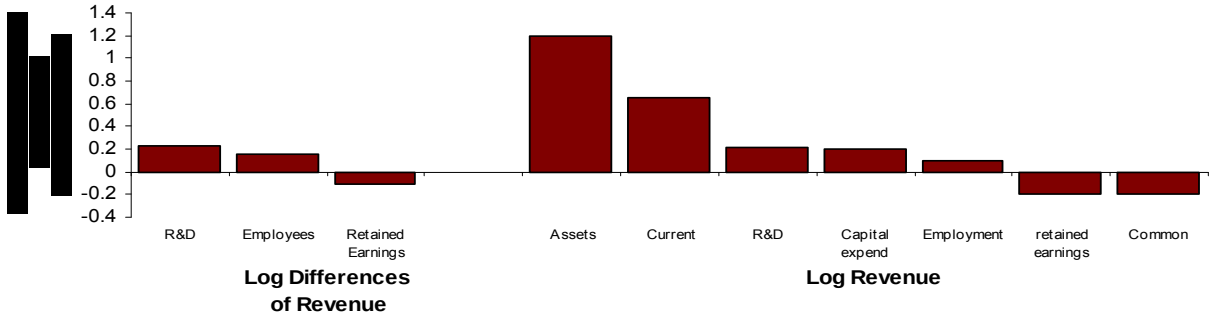


The figure shows the change in profits for a change in the variables shown in the figure. Our city proxy (dummy variable) have the largest effect -- and correlates with differneces in the other variables. To find these results, we regressed the (natural) log value of EBITDA on the log values of the variabes shown. Such a procedures lets each bar in the figure represent an "elastiicity" -- namely showing the change in profits for a 1% change in the variables shown. For example, "cash" seems to promote profit growth twice as much as R&D spending -- albeit a 1% change in R&D spending only increases profits by a quarter-of-one-percent. With high R-squared values, we see that such a geometric model describes well the actual data.
Source: authors.

Other kinds of modelling seem to confirm our initial findings. As for annual changes in EBITDA, capital expenditure had a b-value of 0.68.[231] Such a result means that companies putting in HK$1,000 dollars in capital expenditure (capex) had HK$680 come out in profits for that same year. The R&D expense results though surprise. Such expenses had a value of -2. The latter result means that for every HK$1,000 companies put into R&D, their profits fell by HK$2,000. Yet, the city effect disappears when looking at the way differences in our variables correlate with each other. Our sophisticated modelling provided mixed – yet convincing – evidence that R&D spending and cash help promote the profitability of the kinds of companies Qianhai wants to attract.[232] Method of moments estimation shows the very strong influence of long-term debt on "pure profits."[233] Capital expenditure has a significantly larger effect than R&D spending. Yet, both variables show positive effects – suggesting that any policies aimed at affecting R&D spending, capital spending (or other factors) will increase "pure" profits.

Studies of these firms' revenue performance seem to uncover the relationships we look for better than profit performance. Figure 48 shows the way that revenues have correlated with various factors describing innovative company performance in the Qianhai region. Most relevant for our analysis, company sizes – as measured by their total assets – correlate with revenue growth. **Qianhai will likely boost profits in Hong Kong and Shenzhen only if the Qianhai project encourages size (ie the growth of innovative sectors).**

Figure 48: R&D Seems to Have More Effect on Top Line than On Bottom Line Suggesting that Innovation Spending Affects Competitiveness Somehow



The figure shows the elasticities of revenue with respect to the variables shown for companies in Hong Kong and Shenzhen working in sectors targeted by Qianhai. We report these data only to hone our intuitions about how the variables in our model change in relation to each other. Revenues seem to change the most for changes in R&D spending (though of course we do not know about causality). The size of a company's total assets and current assets seem to correlate with revenues. Source: authors.

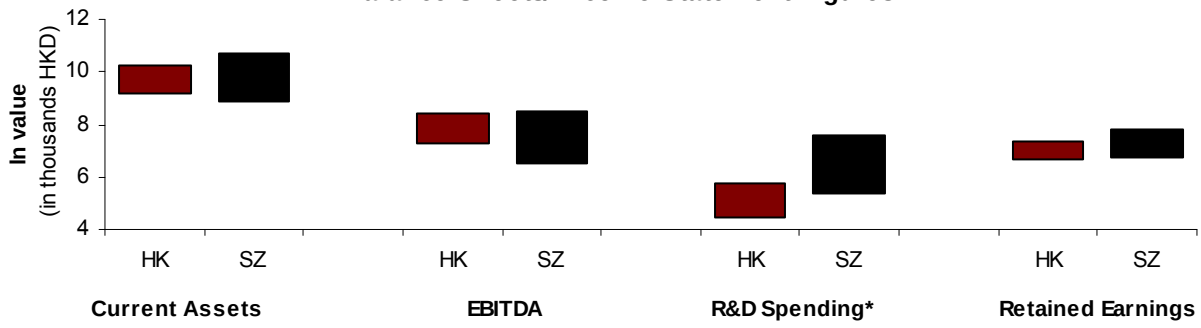
What effect does more cash have on R&D spending – and innovation-led profits? The Qianhai project is futile if Shenzhen's innovative sectors can not benefit from having Hong Kong deliver

[231] These results come from Figure A5.
[232] We describe the results shown in Figure A6 in this paragraph.
[233] "Method of moments" refers to a generalisation of linear regression, which takes care of non-linearities, heteroskewdasticity, endogeneity and other problems. Arellano provides a good overview for readers unfamiliar with the procedure. As described previously, we constructed and used a measure of "pure" profits to look at profits while controlling for the accounting definitions that would automatically affect the way profits move as other parts of the balance sheet/income statement change. See Manuel Arellano, Sargan's Intrumental Variables Estimation and the Generalized Method of Moments, 20 Journal of Business & Economic Statistics 4, 2002.

more cash/investment. The initial data though do show a trend. Looking at the albeit unreliable levels data, we see that cash likely falls very slightly when profits rise – calling into question the idea that more profitable companies will pull in more investment.[234] Cash rises by around $6 to $9 for every $1 put into R&D – suggesting that R&D spending pays off in attracting investment more than in making companies profitable. Yet, these effects vanish when we look at "pure" cash – by isolating cash from the way it is generated in the balance sheet/income statement. The geometric study looking at cash/investment shows that the Qianhai region's innovative companies raised their cash by about 2% for every 10% increase in profits and in R&D.[235] The most sophisticated analysis confirms these effects – and the sizeable impact of profit/R&D on cash.[236] **In isolation, these results suggest that Hong Kong needs Shenzhen much more than Shenzhen needs Hong Kong.**

A detailed look at city-level data suggest that the relationships illustrated above describes Hong Kong about as well as Shenzhen. Figure 49 shows the ranges of average current assets, R&D spending, EBITDA and retained earnings (with retained earnings presented only for illustrative purposes). As we see, the likely range (at the 95% confidence level) for the average of each of these variables overlaps between Hong Kong and Shenzhen. Detailed statistical analysis – presented in Figure A4 – shows a difference in the magnitude of R&D spending between Hong Kong and Shenzhen. Yet, as only highly sensitive statistical methods can pick up this difference (which appears or disappears according to the statistical test used), differences at the aggregate level seem slight.[237]

Figure 49: The Qianhai Region's Innovative Companies Have Few Differences in Overall Balance Sheets/ Income Statement Figures



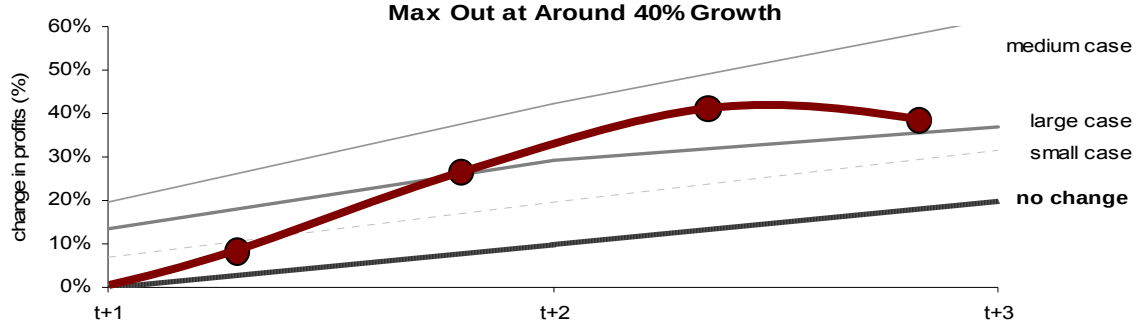
The figure shows the 95% confidence intervals for the natural log of the variables shown in the figure for amounts expressed in thousands of Hong Kong dollars. The significant overlap in the ranges covered by these bars indicates that these companies do not seem to differ significantly from each other on an aggregate basis. Variances with an asterisk (*) indicate that statistical testing -- as reported in Figure A3 -- found differences due to more than random chance. Source: authors.

[234] Shown in Figure A11.Namely cash like current assets fall by $1 for every 0.5 to 1 drop in EBITDA.
[235] See Figure A12.
[236] Figures A13 and A14 show the J-statistics from our method of moments analysis. We can not know the size of the effect from this analysis – as method of moments type tests the scale of effect size by using the variance of the relevant variables involved.
[237] We underline "at the aggregate level" because at the firm-specific level, differences help us find relationships which we use to estimate our model.

Promoting innovation in the short-term

What effect would our proposals have in the short-term (namely out of equilibrium)? Figure 50 shows the effect of reforms we recommended earlier in this paper – but only for the short-run.[238] We see that in the shortest part of this short-run, profits would likely increase by around 10% -- as the Qianhai Authority encourages structural reform. In later periods, profits increase for two reasons. First, innovative companies continue to benefit from previous periods' policy changes – as innovation profits tend to "snowball" or rely on previous year's profits and market sizes. Thus, even if the Qianhai Authority somehow temporarily managed to reform innovation policy – and completely reversed these changes later – profit growth should still rise. Second, Authority will likely engage in further reform. Previous years' reforms will show increasing profits – building support for more reform.

Figure 50: Changes in Qianahi Out-of-Equilibrium Profits Over Reform Cycle Likely to Max Out at Around 40% Growth



The figure shows the effect on profits of a change in the structural parameters which the Qianhai Authority might bring about. Specifically, the figure shows the change in profits (in percent) for parameter changes (*a* through *g*) in our structural model over a four period horizon (with the base case as case number one). See Figure C2 for the formulae used to create this figure.
Source: authors.

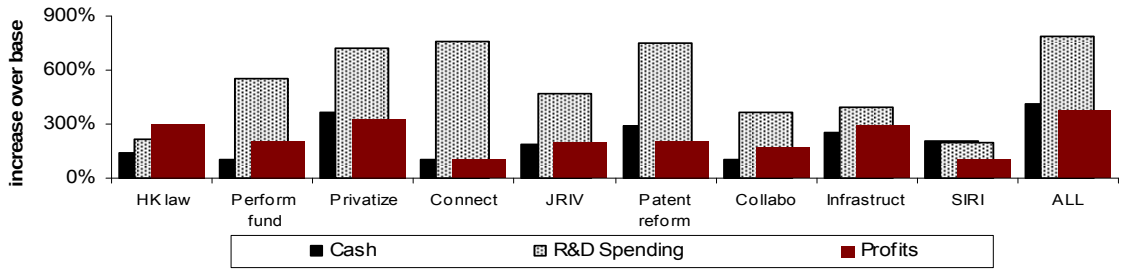
The figure also shows us several interesting things about the way innovation and policy reform promotes growth, even outside the Qianhai context. First, even with no change in policy, growth continues in an upward direction – not just profits, but the growth of those profits themselves... at least in the short-term. We see such an effect purely due to the geometric nature of innovation-led growth. As cash increases, R&D funding grows, profits increase, and the cycle continues in the short-run. Second, medium levels of reform actually lead to the fastest profit growth rates. Just speaking about the mathematics of our model, as serious reform occurs, a large-base effect takes over and growth rates plummet.[239] Third, over time, this example suggests that governments looking to max-out short-term profit growth (maybe for political reasons) will want to delay large-scale reforms basically forever.

[238] We have used our basic model, assumed that Qianhai Authority policy changes each of the parameters as we describe in Appendix II, and modelled the extent to which the Authority pursues these reforms by higher parameter values. She the Appendix for more information on this figure's construction. We refer to the short-run, as we conduct the same analysis later, looking at how Qianhai Authority policy changes affect equilibrium and optimal values of profits, investment and R&D spending.

[239] For the mathematically minded, as our parameters like a, b and so on reach 1 or higher, changes from the previous period become less. As a result, growth "slows" – even if such reform actually improves long-term profit prospects.

While each of the legal changes we propose works together with the others to promote profit-led innovation in the Qianhai region, we can illustrate – using estimates from our model – how specific legal reforms contribute to area growth. Figure 51 shows the estimated impacts on profits of each of the major areas of reform which we propose.[240] Out-of-equilibrium, the increased adoption of Hong Kong law in the wider Qianhai region should increase profits by around 300%. Patent reform would have a far greater effect on R&D spending that on profits in the short-term. Unlike in the figure above, this illustration shows the total expected effect, over all time (whereas the figure above shows growth in specific periods for specifics levels of reform). **Yet, the figure provides a useful illustration – showing the reader how our legal proposals link to our model and thus to our estimated impacts on the Qianhai region's innovation-led profits.**

Figure 51: Privatizing the Qianhai Authority and China's Infrastructure Investment Look Like the Best Ways to Increase Out-of-Equilibrium Short-Run Profits



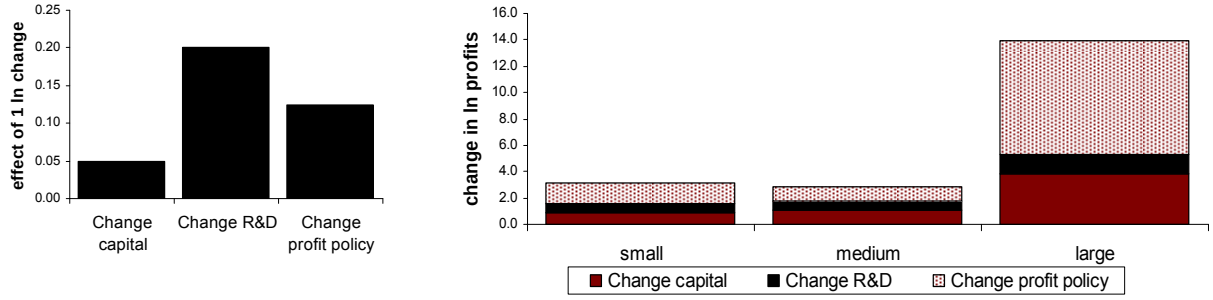
The figure shows the predicted effects on profits, likely R&D spending and "cash" if the Qianhai authorities adopted the legal changes proposed in this paper. The results specifically show the values our model predicts for the parameter changes corresponding to each reform (which we described in the Appendix). We do not show any adjustment -- as we do not want to give these estimates too much weight. Instead, we use these data to illustrate how each legal proposal contributes to the aggregates we present throughout this section of our study.
Source: authors.

What effect would simply giving more resources to innovative companies have on Qianhai-region profits? As we showed in the literature review, much existing policy aims at showering start-ups and other companies with resources in the hopes of overcoming some kind of start-up externality.[241] Figure 52 shows the effect of giving resources to companies like the ones we used in our study. The change in profit policy specifically refers to resources used to find ways of encouraging companies to reduce spending or otherwise retain earnings that would otherwise dissipate in business spending of various kinds. Thus, the change in profit policy neither represents a windfall "profit" subsidy nor a "structural reform" has we have defined them.[242] **For now, increasing spending on R&D provides the best kind of direct-support – though**

[240] To arrive at this figure, we used the structural parameters estimated from our econometric analysis, bumping up or down specific parameters according to the area each reform would impact. We used historical data, as we describe in the statistical appendix, to estimate how much the reform – if adopted as we suggested – would change the parameters shown in the figure. With these new parameterizations, we simply re-ran the model, simply reading off the predicted amount of cash, R&D spending and profit from each variant of our core model.
[241] For a concrete example of the type of policy discussed here, see Interim Measures on Financial Subsidy for Individual Income Tax of Overseas High-level and Short-supplied Talents in Qianhai Shenzhen–Hong Kong Modern Service Industry Cooperation Zone of Shenzhen (Shen Fu [2012] No. 143, December 24, 2012, available online.
[242] We have reserved the term structural reforms in the context of our model as policies which change the model's parameters (as opposed to looking at the effect of changing variable values, as we do in this figure).

structural reform generates far more profitable innovation than simply dumping resources on Qianhai region companies.

Figure 52: Qianhai Innovation Policy Will Do Far Better to Change Improve the Innovation System Instead of Airdrop Resources



The figure above shows the predicted effect, from our calibrated model, of resource transfers to innovative companies in the Qianhai region. The left part of the figure shows the effect of increasing resources by one "order of magnitude" (as we describe in the Appendix).

What kind of assistance should the Qianhai Authority give? Figure 53 shows the major policy rules which we derive in our model for how the Authority should promote profit-led innovation in the region. As shown in the appendix, the value of structural reforms equals the magnitude of the current spending multiplied by that current spending. For example, suppose Qianhai's authorities wanted to attract investment (cash) by using increased R&D spending to entice investment. Thus, if R&D spending equals HK$100 million, structural policy change would produce the same results as if the Qianhai authority plopped down $1.8 billion of its own money.[243] The Authority should focus mainly on structural reform – supporting infrastructure (as it does) and privatising (which it will certainly never do). The Hong Kong, Shenzhen and Qianhai authorities' plans to simply dump resources on start-ups and other companies should focus on finding ways to let these companies keep profits. **Governments' support of R&D and investment promotion provides far less effective ways of encouraging innovation-led profits in the Qianhai region.**

[243] As we show in the appendix, changing a parameter (the parameter *c* in the case we are talking about in the text) produces ln(X)*X in extra cash. Yet, the difficulties involved in pushing the parameter *c* by a full point may make writing a $1.8 billion cheque seem palatable.

Figure 53: Model Predictions for the Best Way the Qianhai Authority Can Spend its Resources in the Short-Term

1. The Qianhai Authority should focus on providing resources for structural change of the **climate for innovation** in the following order:
a) infrastructure
b) privatising the innovation authorities,
c) adopting HK law in the Qianhai region, and
d) patent reform (in that order).

2. If the Authority must give subsidies, do "resource drops" and otherwise give away money, it should give these resources in the following order:
a) using resources to work on the activities listed above first (like infrastructure, privatising the innovation authorities, and so forth),
b) adopting profit-enhancing policies (tax rebates and policies which allow companies to keep more of their hard-earned cash),
c) giving loans and other cash-like assistance which firms can use at their discretion,
d) funding of R&D (laboratories, research equipment, staff, etc.).

3. Actions from the first list are strictly preferred to those on the second list.

Note: Particularly with point 2, the Authority should only engage in such funding to the extent it corrects a market failure. The parameters estimated for our model do not point to the need for subsidies which correct pre-existing market distortions.

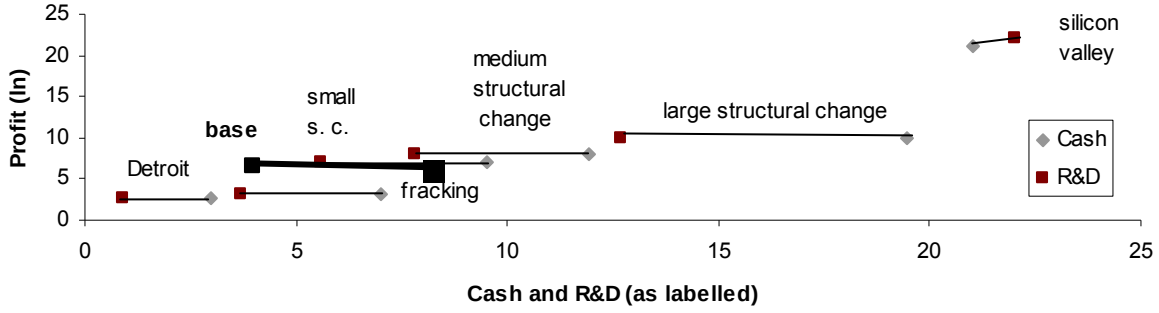
Finding and changing equilibrium profits for the Qianhai region

What do profits, R&D spending and cash look like in equilibrium? Namely, if companies just continued to work as usual without any government push, where would their profits settle to in the longer-run? Unsurprisingly, even the magnitude of equilibrium profits increases exponentially as other spending (on things like capital, researchers and so on) increases exponentially.[244] Figure 54 shows the equilibrium level of the Qianhai region's innovative companies' profit, R&D spending and cash – compared with both other types of jurisdictions and with the levels attainable if Qianhai's authorities adopt the legal reforms we describe in this paper.[245] As shown, profit levels remain lower than if the Qianhai authorities adopted the reforms we described above. Current levels certainly exceed those of the "Detroit" and "Fracking Case" -- examples we use as comparisons (see appendix for more details on these comparators).[246] Qianhai's companies' profits remain far lower than in the Silicon Valley case

[244] The figure shows the magnitude of profits compared with the magnitude of other spending (as the natural log or ln represents this magnitude).
[245] Readers interested in the statistics used to calculate these figures should see Figure D8.
[246] The Detroit case represents a parameterisation of our model whereby R&D, cash and profits have a very weak relationship with each other. The Fracking Case refers to a parameterisation in which a technological advance causes increases in investment and profits, without the need for much R&D.

we describe in the appendix. **The astute reader will note that even with reform, Qianhai companies will require more and more money to squeeze more profits out.**[247]

Figure 54: Structural Changes on Innovation-Led Profits in a Comparative Context

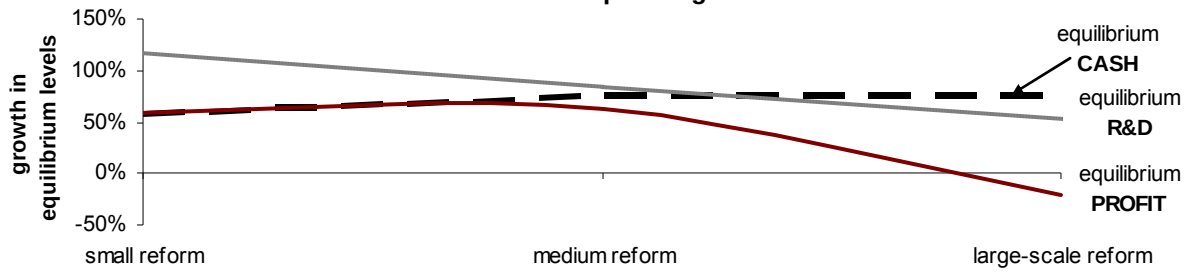


The figure shows the policies characteristic of the situations labelled in the figure. For example, "Detroit" shows the case of a sunset industry with little innovation. We compare each of these archetypes with the structural changes described in the paper. We provide the calculations used to produce this figure in Appendix II.
Source: authors.

Unsurprisingly, legal reforms aimed at increasing the profitability of Qianhai's innovative companies suffers from diminishing returns. Figure 55 shows the growth rates of equilibrium profits, cash and R&D for the three cases corresponding to the extent of legal reform adopted by the Qianhai region's authorities. Small reform naturally results in the largest boost to equilibrium profits – requiring a much larger equilibrium increase in R&D spending (well in excess of 100% per time period). For extensive legal reform, profits can actually shrink (if too extensive) as companies eat up resources to fund R&D and attract cash. If our model reflects reality, these data highlight a dangerous pitfall. **Qianhai authorities and companies which pursue innovation and investment too vigorously may cause the local innovation system to destroy profits <u>in equilibrium</u>, thereby undermining the entire innovation-led reform.**

[247] The less astute reader will draw a mental line through the small, medium and large structural change cases shown in the figure. That mental line traces out a relatively flat relationship between profits and cash/R&D spending (of about 5 magnitudes of profits gained for every 10 magnitudes of cash and R&D).

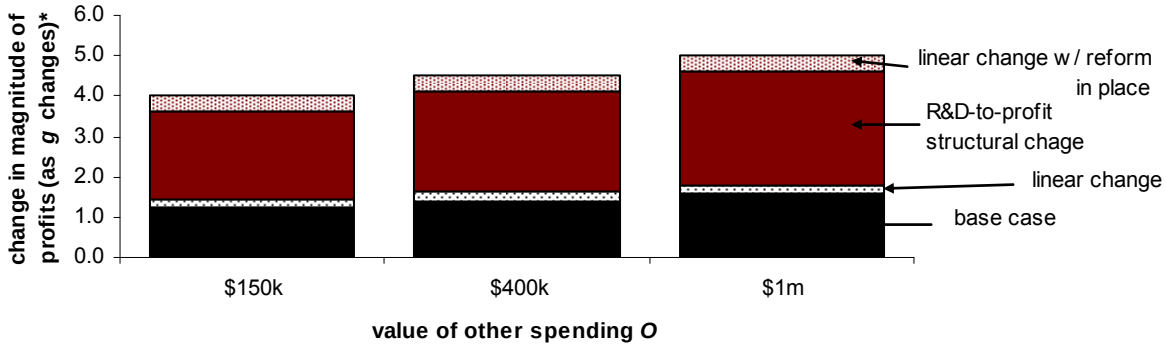
Figure 55: The Growth of Equilibrium Profits Falls as Reform Speeds Up While Less R&D Spending Does More



The figure shows the predicted change in static equilibrium of cash, R&D spending and profits from their current levels as the Hong Kong, Shenzhen and Qianhai authorities engage in the legal reforms described in this paper. We describe the model used, the equilibrium solutions and the changes in parameterization done in order to make these predictions in the appendix.
Source: authors.

As with the out-of-equilibrium case, the right amount of structural reform will benefit Qianhai's innovative companies far more than simply spending more on capex or "other" spending. Figure 56 shows the change in profits accruing from the legal/structural changes we previously advocated, making R&D more profitable. Profits naturally rise as other spending increases. Yet, with structural reform, profits at every level of other spending increase by a factor of around 3-4. Legal changes which make profitability more responsive to R&D and other spending have a very marginal effect.[248] The very thin wedges in the bars represent these effects in figure. Legal changes which make the size of such spending itself a key factor (even if/when R&D spending itself is not changing) have the dominant effect on profits. These "geometric effects" caused by legal changes boost equilibrium profits by 3-4 orders of magnitude.

Figure 56: Equilibrium Profits for Qianhai Increases More with Structural Change Than For Simply Spending More on CapEx and "Other" Expenses

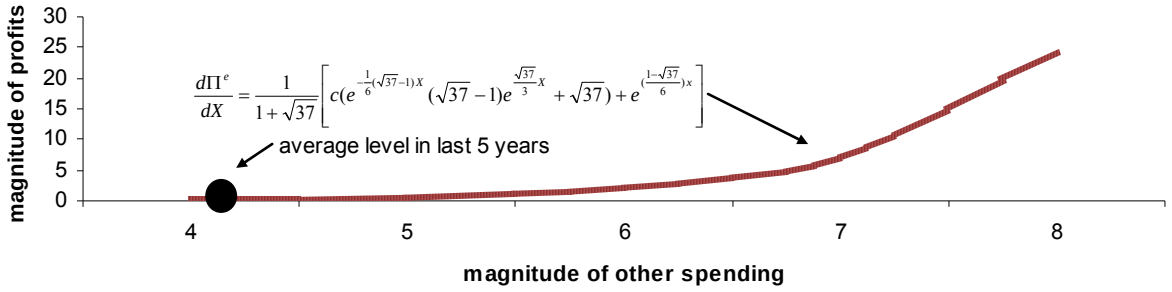


The figure shows the size of profits under a number of different scenarios. The black part of each bar shows the magnitude of profits under the status quo, for different levels of other spending O. Structural changes which affect the linear part of profit growth have a slight affect on profits (as shown by the small layers in between the black and red parts of the bars). Implementing R&D-to-Profits structural change causes profits to increase geometrically. The more companies spend on other spending O, the more effect these structural changes have.
Source: authors.

[248] Such changes make changes in R&D and other spending important determinants of profitability. In our model, linear parameters pick up the effects of such reforms.

How can the size of R&D or other spending affect profits in equilibrium – even if R&D spending does not increase? Figure 57 shows how the equilibrium profits of Qianhai's innovative companies change in response to a bit more R&D spending – for different levels of other spending.[249] A bit more R&D spending causes the equilibrium level of profits – namely the level of profits these companies should earn in the long-run and ignoring other temporary effects – to rise only slightly for companies spending modest amounts of money on capex and "other" expenses.[250] Yet, if the Qianhai region's companies on average increase the magnitude of their other spending by a factor of 4, profits would grow by a factor of around 20!

Figure 57: Predicted Change in Qianhai's Equilibrium Profits as the Equilibrium of Other Spending Rises

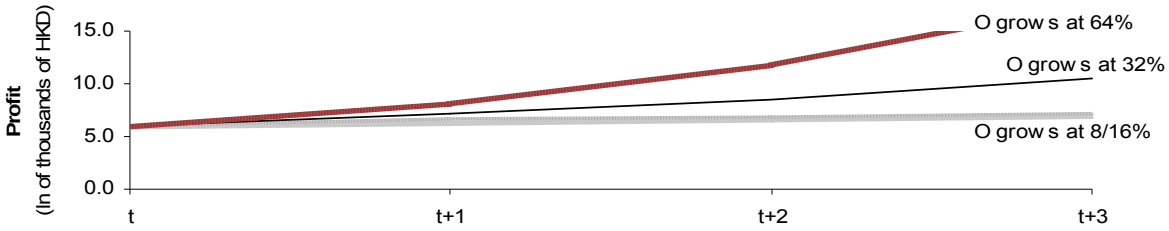


The figure shows the change in the equilibrium profits of the Qianhai region's innovative companies when other spending changes -- using existing structural parameters (namely before any kind of reform). See the appendix for the explanation of how we made these calculations.
Source: authors.

How fast would the adjustment take? How fast would average equilibrium profits grow in response to changes in the growth of these other expenses? Figure 58 shows our model's predictions for the growth in the levels of profits corresponding growth rates of other expenses.[251] Growth rates of other spending at 8% per period or 16% barely impacts on the magnitude of profits like faster growth rates do. From current profit levels, only very large growth in other spending moves profits significantly per period. We talk about "periods" in this figure, in order not to tie our predictions to calendar time. In this way, whenever other spending O increases for the first time by 64%, we should expect to see the corresponding change in profits – no matter what time period this corresponds with in the real world. **In equilibrium the feedback between cash, R&D spending and profit generation causes profits to adjust by such large amounts over time to changes in other spending like capex.**

[249] We show the specifics for this figure calculation in the statistical appendix.
[250] "A bit more" in this context refers to the change we all learned about in our high school calculus classes. For readers with a grounding in maths, we describe the value of the derivative of equilibrium profits with respect to R&D spending as a function of other spending *O*.
[251] We could have simply presented the growth rate of profits on the y-axis. We choose this unusual presentation in order to show what happens to the magnitude of profits. Growth rates abstract from the real situation so much that readers may not otherwise be able to link these data to the real world.

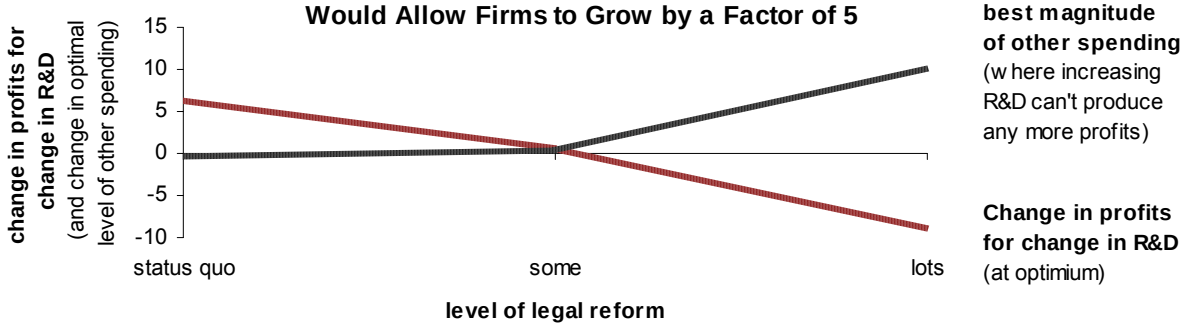
Figure 58: Equilibrium Profits Change Quickly As Other Expenses Change Due to the Feedback between Cash, R&D and Profits



The figure shows the predicted growth of EQUILIBRIUM profits in the industries Qianhai targets for the corresponding growth in "other" expenses (capex, employment, etc.) between each period -- according to our model and the parameters we found in econometric analysis. Even growth of these other expenses at around one-third per year would double profits in our target industries. The main policy question thus becomes -- can an integrated Qianhai region better achieve this growth of other expenses than the two jurisdictions separately?
Source: authors.

At least for now, the largest amount of legal change does not necessarily bring about the most profits for Qianhai's innovative companies. Figure 59 shows the relationship between the extent of legal reform (as we described previously) and the profitability of innovation in the Qianhai region. The figure shows that – at present – profits increase with more R&D spending without requiring other spending *O*. With a lot of reform (as defined by new parameters in our model corresponding to this new status quo), significant extra other spending only causes profit destruction. At the point we marked as "some" legal reform (which corresponds to specific parameters in our model which you can find in the appendix), the losses that other spending cause offset the gains they produce in helping R&D to generate profits. **Thus, some mix of our legal proposals, and five times current "other" spending, will maximise profits in the Qianhai region at the point where the cost of extra investment and spending exactly offset the gains they produce in facilitating the profitable exploitation of R&D.**

Figure 59: Structural Reform of Qianhai's Innovation System Would Allow Firms to Grow by a Factor of 5



The figure shows that best ln O with lots of reform is roughly five magnitudes higher -- this means that that the firm size where R&D cant produce more profits is five orders of magnitude larger.
Source: authors.

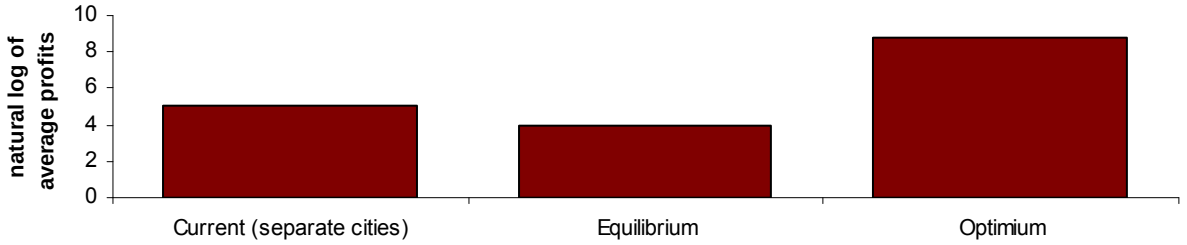
$$\frac{d\Pi^{e}}{dX} = Q + \frac{-(ad+e)g^{2}+(1-cd)g)}{(f+b)}\ln^{-1} O \ln O\Big|_{\frac{d\pi}{dX}=0} = \frac{(ad+e)g^{2}-(1-cd)g)}{(f+b)Q}$$

$$Q = -(ad+e)g^{2}+(1-cd)g)\left(\frac{1}{ag+c}\right)\ln^{-1}\beta + \left(\frac{1}{(a+ec)}\right)\ln^{-1}\gamma + \left(\frac{1}{(1-eg)}\right)\ln^{-1}\alpha$$

Optimal profits and the costs/benefits of a Qianhai Authority

The market structure for innovative companies' prevents them from achieving their optimal profitability. Figure 60 compares average profits under three cases for companies in the sectors that Qianhai's policymakers want to focus on. The first bar on the left side shows profits, as we observe them in the real-world. The next bar shows equilibrium profit levels of about 1-2 magnitudes higher than current out-of-equilibrium levels. Finally the last bar shows the static optimal profit level, assuming that the Qianhai Authority provides the right support for innovative companies in the Qianhai region.[252] **Similar to the previous calculations we showed, the Qianhai Authority has the opportunity to raise profits four fold in the Qianhai region.**

Figure 60: Even Under Today's Market Conditions, Qianhai's Profits Optimally Increase Four Fold



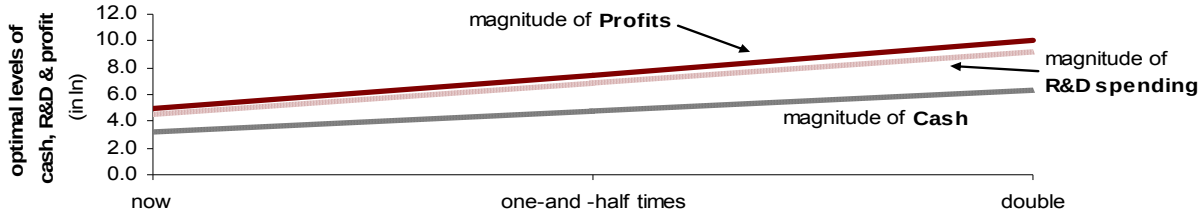
The figure shows the average size of profits in the Qianhai region for the companies that the Qianhai authorities hope to attract. We show the equilibrium profit level (once Hong Kong and Shenzhen reach theirproductivity plateau) and we show the optimium profits (as the level where diminishing returns make further profits impossible). Even before considering profits over time -- in other words, this is a static analysis - Qianhai has extraordinary room for growth. Source: authors (based on data provided by Compustat, 2016).

What effect can the legal reforms we propose have on innovation-led profits in the Qianhai region. Figures 61 show the way that authorities' actions – and "other" spending – affect optimal profits, R&D spending and cash-raising. In each case, optimal profits increase by around a factor of five(5). [253] More reform (looking at the levels of the variables across each of the graphs) shows correspondingly more R&D spending and investment/cash generation – with the highest values corresponding to a medium level of legal reform. As we previously stated, other spending effects the level of profits and other variables – but does not change the fundamentals of the innovation system(s) driving these profits. **These figures thus predict that legal reform in Qianhai will affect Hong Kong and Shenzhen's position as a financial centre far more than their profitability.**

[252] Such "optimal support" refers to spending on the programmes we previously described, as a way of increasing the values of our parameters *a-g* and alpha, beta and gamma. We refer to the static optimum, as we use techniques appropriate only for one period. When we look at the dynamic optimum, we take into account tactical savings or forbearance in order to promote even faster growth later.

[253] For readers who find the figures difficult to read, note that even with double the current level of "other" spending, the magnitude of optimal profits always come to around 10 (from a level of around 5) for the range we show.

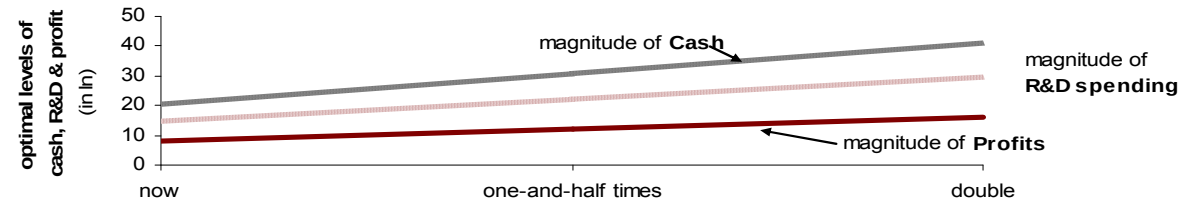
Figure 61a: Optimal R&D Spending Much Higher than Equlibrium Level in Order to Maximise Innovation Sectors' Profits in the Qianhai Region



The figure shows the optimal levels of R&D spending, cash, and profits for innovative firms that Qianhai hopes to attract - assuming no structural reforms undertaken. See Appendix for the procedures used to calculate these figures. For mathematical readers, these are the optimal values found from Lagrangian maximisation, for the structural dynamic model we tested from econometric analysis.
Source: authors.

Estimates for the STATUS QUO in Which Qianhai Adopts NO Innovation Law Reforms

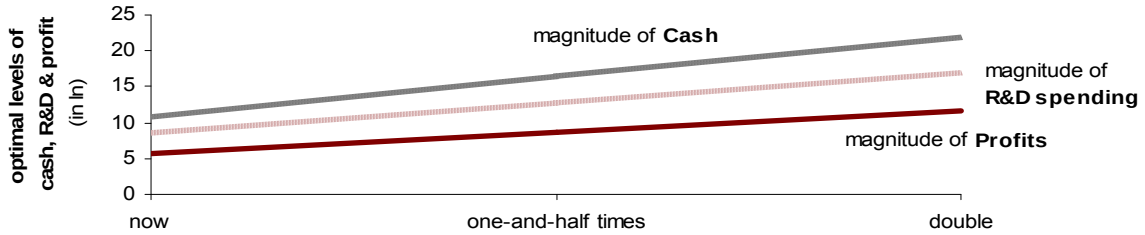
Figure 61b: Limited Legal Reform Encourages Qianhai's Innovative Firms to Attract Investment Above All Else



The figure shows the optimal levels of R&D spending, cash, and profits for innovative firms that Qianhai hopes to attract - assuming the "small reform" case's parameterization of our model. no structural reforms undertaken. See Appendix for the procedures used to calculate these figures. For mathematical readers, these are the optimal values found from Lagrangian maximisation, for the structural dynamic model we tested from econometric analysis. Source: authors.

Estimates for the Case in Which Qianhai Adopts LIMITED Innovation Law Reforms

Figure 61c: Extensive Legal Reform Makes Qianhai's Innovative Firms Small and Efficient Cash Seekers in a Larger Financial Centre

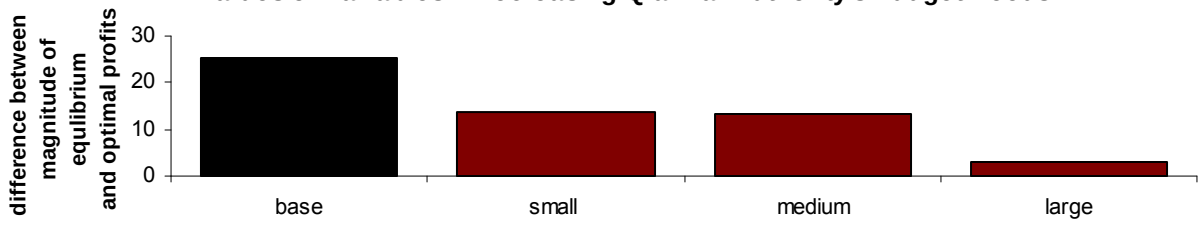


The figure shows the optimal levels of R&D spending, cash, and profits for innovative firms that Qianhai hopes to attract - assuming the "large reform case" we describe in the paper. See Appendix for the procedures used to calculate these figures. The changes in the x-axis represent the only real change in this figure from the previous one.
Source: authors.

Estimates for the Case in Which Qianhai Adopts EXTENSIVE Innovation Law Reforms

Legal reform has another effect which should interest policymakers. Figure 62 shows the difference between equilibrium and optimal profit levels over a range of reform "levels."[254] Various levels of legal reform correspond to roughly the same level of profits. In the figure, we see that at present equilibrium profit levels fall short of their optimum by about 20 orders of magnitude! As Qianhai region authorities undertake innovation-oriented legal reforms like those we have previous advocated, equilibrium levels of profits increase (and optimal levels decrease).[255] **More reform increases equilibrium levels of profit – bringing equilibrium levels of profits closer to their optimal levels.**

Figure 62: Structural Reform Decreases Distance Between Optimal and Equilibrium Values of Variables -- Decreasing Qianhai Authority's Budget Needs



The figure shows the difference between the equlibrium and optimal amount of profits earnable by the companies the Qianhai Authority targets. As Hong Kong, Shenzhen and Qianhai engage in structural reform, profits become more self-reinfocing (meaning that the Qianhai Authority won't need to spend as much every year correcting market failures).
Source: authors.

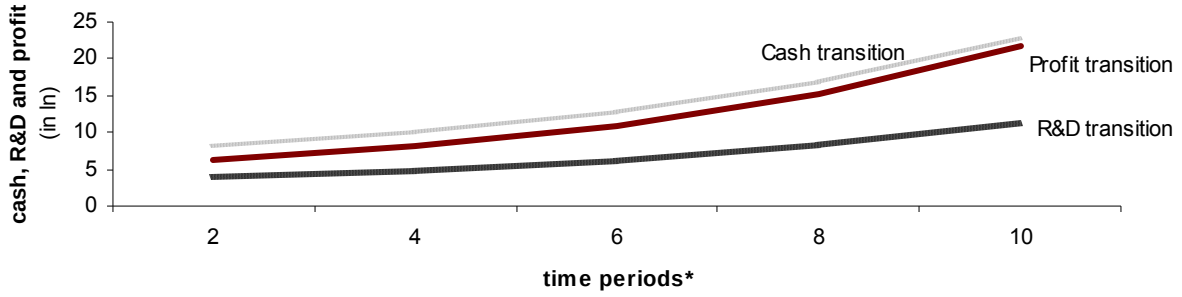
How Should the Qianhai Authority Plan its Reform Over the Next 5-10 years?

Luckily, the Qianhai's optimal levels of profits, R&D spending and cash increase over time. As shown in Figure 63, optimal profits increase by a factor of four over a ten (10) period time frame. Cash increases even faster, providing further support for the proposition that innovation policy can help boost the Qianhai region as an international financial centre. Not surprisingly, equilibrium R&D spending grows more slowly – as efficient innovation saves R&D resources. R&D spending, in our model, represents a means to an end (higher profits). As such, and under our assumption that Qianhai authorities care mainly about profits, minimising R&D spending can only contribute to profits. How do equilibrium levels of our dynamic variables relate to their equilibrium levels? Figure 64 shows the way the equilibrium levels of profits, R&D spending and cash change as other spending changes. Other spending – on capex, employment and so forth – has the most effect on the equilibrium level of profits. Other spending increases R&D spending (as R&D spending clearly complements other productivity improving expenditures). The dynamic equilibrium level of cash falls as other spending eats up resources. We can find the difference between optimal and equilibrium profits, R&D spending and cash by simply

[254] As we have reminded the reader on numerous occasions, each level of legal reform corresponds with specific actions (like patent reform, privatisation of government-led innovation agencies and so forth). Each of these actions in turn corresponds to different parameters in our model. Thus, we can show how different levels of legal reform correspond with different predicted equilibrium and optimal levels of profits, R&D spending and cash generation.
[255] We previously showed the size and nature of these decreases. Optimal profit levels fall as efficient methods of production reduce the scale of innovation sectors in Qianhai and pull in more resources (which increase costs, scale and thereby decrease profits).

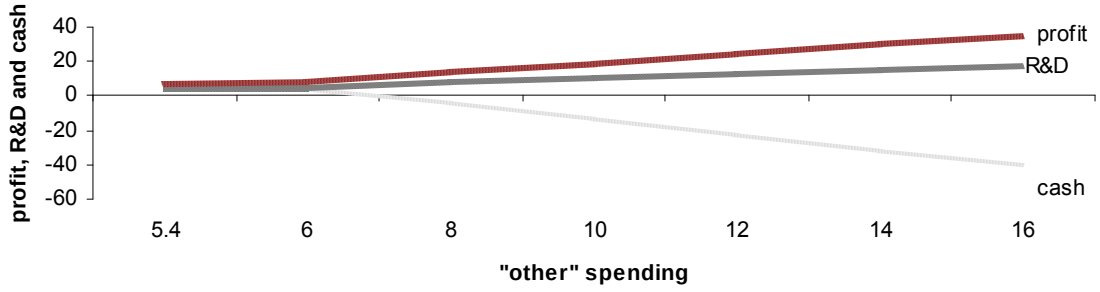
comparing Figures 63 and 64. **As such, a Qianhai Authority must adopt policies which make Qianhaiese firms increase "other" spending up to the point where the equilibrium profit level matches the optimal profit level.**[256]

Figure 63: The Adjustment to Optimal Profits in the Qianhai Region Has A lot of Investment and Not Much R&D Spending



The figure shows the "short-term" adjustment path for innovative companies in the Qianhai region (in so much as one can talk about such a short-term or adjustment in a system constantly exposed to shocks). We obtain these data by finding the way that each variable adjusts over time to its own size -- keeping in mind that these variables depend on each other. Mathematicians know this is a system of (non-linear) differential equations. We show only the short-term "adjustment" -- providing details about how we made these calculations in the Appendix.
Source: authors.

Figure 64: Long-Run Equilibrium Shows Profits, R&D and Cash Pay-Backs For Higher Levels of Other Spending (like Capex)



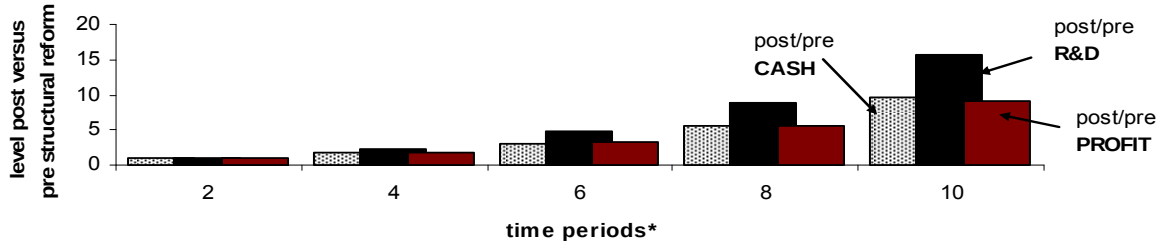
The figure shows the equilibrium levels of profits, R&D and cash if the world suddenly came to a stand-still. We computed these numbers by looking at the way profits, R&D and cash change over time as a function of their own size. Mathematicians know this as system differential equations. We show the predicted "steady-state" -- for various levels of "other" spending. See Appendix for methods used.
Sources: authors.

From a dynamic perspective, we see that full legal reform maximises profits over time – with the magnitude of profits increasing by around 10 fold from current levels. Figure 65 shows the difference between cash, R&D spending and profits between the no-legal-reform case and the full reform case (with partial reform cases lying somewhere in-between these two extremes). For example, we see that after 10 periods, R&D spending maxes out in the full-legal-reform case by a

[256] Any discussion of these policies would take us far outside the range of this paper. Numerous papers discuss the ways policy can encourage capital spending, employment, the accumulation of assets and so forth.

factor of around 15 times above their level if no reform occurred.[257] The level of cash of these innovative firms comes to over 10 times their level without reform – and profits come in at a bit less. These results strike at the heart of the politics of innovation policy reform. **Qianhai authorities' adoption of radical legal reform will cause short-term profits to decline – even if it later causes these profits to grow faster than otherwise.**

Figure 65: Structural Reform of Innovation in the Qianhai Region Would Allow Profits To Grow 10 Times Larger over a "Decade"



The figure shows the proportion of optimium profits, R&D spending and cash available to Qianhai companies during their short-term adjustment period. We calculated these data by finding the trasition part of the solution to a system of differential equations for a new set of "structure reform" parameters compared with the previous solutions we have already shown. Thus, the data above show the proportion of the solutions (for these new "structural reform" parameters we used in the original structural equations) compared with the previous solutions we showed. We provide detailed information on the techniques we used to calculate these numbers in the Appendix. The "periods" shown in the figure may not necesssarily correspond with calendar years (as this depends on the adjustment speed of reform and other factors we also describe in the Appendix).
Source: authors.

Conclusions

Qianhai – a glamorized real estate development project so far – holds the potential to radically reshape innovation policy and finance in Hong Kong and Shenzhen. If politicians rally around Qianhai, one could even talk about a Qianhai region – the cross-border harmonization of policy which would make Hong Kong and Shenzhen look much more like San Francisco and its Silcion Valley hinterland. To date, policymakers and analysts alike misguidedly focused on investment and innovation – ignoring the vital role of profit. Companies will move to Qianhai – just as Qianhai will "move" into Hong Kong and Shenzhen – in search of higher profits. Governments and companies will participate in the Qianhai project if they can make more profits doing so than they do now. Will they?

In this paper, we show that Qianhai has the potential to increase average profits from innovation by a factor of ten (10) in the long-run. Even in the short-run, legal reform of the regulatory environment governing Qianhai can pull up profits from innovation-focused Hong Kong and Shenzhen companies by a factor of four (4). Without reform, Qianhai will remain just another real estate development. These reforms include privatising the existing innovation authorities, requiring a profit-orientation, encouraging patent reform, and enshrining legal changes into business-university collaboration.

[257] We have previously described how to interpret periods -- as the time companies and authorities need to carry out activities measured in years in the past. Because these companies and government agencies can choose how fast to reform, spend a certain amount of "other" spending, or engage in other activities, we can not strictly saw that our model's predictions will occur in calendar time.

We analyse the optimal design of Qianhai in three major parts of our paper. The first part of the paper draws on the tools of public policy and economics – to analyse the evidence on innovation in Hong Kong and Shenzhen to date. We show the results of previous econometric studies finding serious fault with innovation policies in the Hong Kong – Shenzhen area (an area we optimistically refer to as the Qianhai region in this paper). The second part of the paper uses tools from legal analysis and design. We evaluate existing legal provisions, and describe – using the econometric evidence we found – how concrete redrafting of that law can help improve performance. The third part of our paper presents the results of econometric analysis of the Qianhai region's innovative companies (working the sectors that Qianahi policies hope to target). We use structural equations modelling and method of moments estimation (and other types) to show how profits react to R&D and the availability of cash.

The evidence shows that the existing approach to inculcating innovation in Hong Kong fails. Shenzhen serves as an innovation centre in large part because past access to capital and Western resources which flow through Hong Kong. Reform revolves around two legal instruments. The regulations governing the Qianhai Authority (a local government dependency conceived in regulatory instruments of the State Council and established/operated in/under Shenzhen administrative law) will have a determining effect. Revising them could encourage rewriting the legal instruments governing Hong Kong's own failing innovation bodies. The various agreements made over the years between Hong Kong, Shenzhen and Guangdong authorities represent the pillar for support innovation policies. These agreements, usually written as wish-lists rather than as concrete expressions of the transfer of competencies and obligations, significant hinder cross-border cooperation on promoting innovation.

Successful innovation law – the kind which would bring about the 10 fold increase in the average profitability of innovative firms in the Qianhai region – would look like the following. The Qianhai Authority would be privatized and would be judged based mainly on its own profits – and the profits of the firms it develops.[258] Hong Kong's own innovation bodies – like its science and technology parks -- would be judged similarly. Hong Kong law would govern a larger share of contracts concluded in actual physical locality of Qianhai (the land area in south-west Shenzhen). New regulatory acts would come into force -- governing patent reform and the way universities can deal with companies.

An appendix sketches the Innovation Agency Theorem. In that section, we show how legal changes need to guide structural reform. We also show why structural reform generates more profits than subsidizing R&D and innovative commercial activity. We finally show why markets everywhere – not just in the Qianhai – will fail to bring about the optimal amount of innovation (and thus profit). We finally show exactly how many resources need to be used to reform innovation systems – and what profit-impacts these reforms will have.

If local policymakers implement some of the legal changes we describe, we hope future academics will conduct further econometric testing – looking at the effects of the experiment.

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[258] We intentionally use passive verbs in these sentences to avoid politicising the issues we raise in this conclusion. Read the paper (rather than just the conclusion) for these details.

Appendix I: Qianhai's Preferential Policies and Sectors

Financial services

1. Support Qianhai to become an experimental zone for cross-border RMB services
2. Explore cross-border RMB lending
3. Support Qianhai-based corporates to issue RMB bonds in Hong Kong
4. Support the establishment of Qianhai-based equity investment funds
5. Support foreign funded equity investment funds to develop in Qianhai
6. Support the reasonable lowering the entry barrier for Hong Kong-based financial institutions into Qianhai under the CEPA framework
7. Support the establishment of new financial institutions and exchanges for various financial features
8. Support the establishment of national or international headquarters for domestic and foreign financial institutions in Qianhai

Taxation

1. Companies that are in industries specified in the entry and preferential list will enjoy a 15% income tax rate.
2. Professionals that are in Qianhai's preferential industry list shall receive a provisional subsidy from the Shenzhen government that waives their salary tax requirement
3. Qualified modern logistics enterprises registered in Qianhai can enjoy the preferential Policy on Business Tax

Law

1. Explore the establishment of Hong Kong arbitration institutions' branches in Qianhai.
2. Strengthen the cooperation between law firms in the Mainland and Hong Kong, explore joint-operation and other opening measures to Hong Kong under the CEPA framework.

Talent

1. Develop measures and policies to facilitate foreign professionals, overseas Chinese, and study-abroad nationals to work and live in Qianhai
2. Include Qianhai into the trial areas in Guangdong regarding the mutual recognition on professional qualification.
3. Allow Hong Kong-qualified professionals to provide services to Qianhai-based enterprises and residents. The scope of service is limited within Qianhai.
4. Allow Hong Kong professionals who obtained the qualification as Chinese Certified Public Accountant ("CPA") to be the partners of Mainland CPA firms in Qianhai.

Education and medical services

1. Allow Hong Kong service providers to set-up fully owned international schools in Qianhai after obtaining the relevant approval.
2. Allow Hong Kong service providers to set-up fully owned hospitals in Qianhai after obtaining the relevant approval.

Telecommunication

1. Allow Hong Kong and Macao telecommunications service providers to establish joint ventures in Qianhai with Mainland telecommunications service providers.
2. Encourage innovative management in telecommunications and allow local service providers to explore preferential charge schemes in Qianhai.
3. Support the establishment of a special international communication channel to meet the demand of Qianhai enterprises

The National Development and Reform Commission published the *Shenzhen Qianhai Shenzhen-Hong Kong Modern Service Industry Cooperation Area Preferential Industry List* in March 2012. The list includes six major industries – finance, logistics, information services, technology services, professional service and public services – and the one hundred and twelve sub-sectors under them. The sub-sectors included in each sector include:

Finance: 23 sectors

Including banking institutions, non-bank financial institutions, securities companies, insurance companies, fund management companies, financial feature exchanges, financing and leasing companies, financial guarantee companies, off-shore RMB services companies, etc.

Logistics: 18 sectors

Including supply-chain management companies, shipping companies, shipping broker and information services, delivery services for on-line businesses, aviation equipment trading companies, logistic services for bonded area, services companies for on-line businesses, etc.

Information services: 16 sectors

Basic telecommunication services, value-adding telecommunication services, electronic identification services, digital content services, Internet content development and application services, trusted computing services, Intelligent network services, mobile internet services, the internet of things services, etc.

Technological services: 7 sectors

Domestic and foreign technological research institutes and their branches, international technological innovative institutions, technology development services, technology consultation services, technological achievement transformation and application services.

Professional services: 39 sectors

Accounting services, appraisal services, law firms, consulting services, engineering project services, cultural and innovative services, exhibition services, educational and medical services, human resources services, intellectual property services.

Public services: 9 sectors

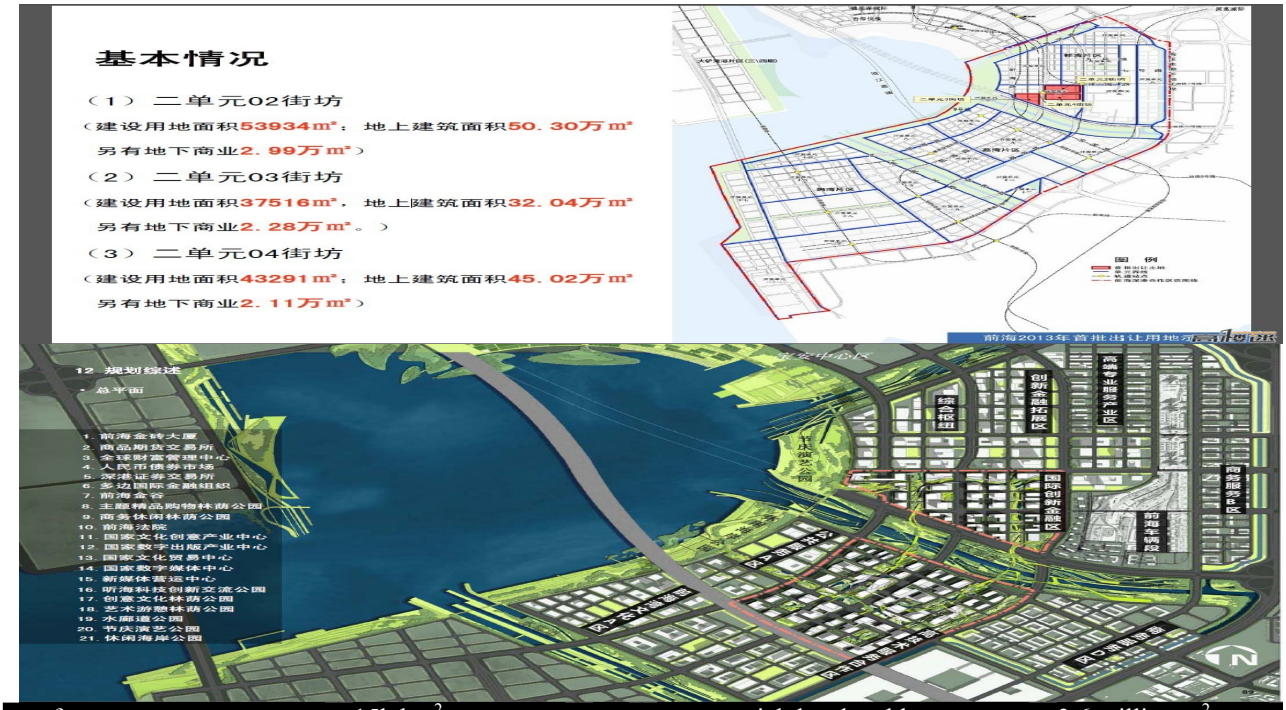
Urban public facility services, environmental protection services, resource recycling services, energy-saving development and application services, yachting and aviation leisure services, social work services.

Source: Tuntono provides the first list, whereas Sharif and Tang provide the second. See Christiaan Tuntono. Hong Kong: Is Qianhai and Opportunity or Threat, Credit Suisse Economics Research, 2013, available online. See also Naubahar Sharif, Hei-Hang Hayes Tang, New trends in innovation strategy at Chinese universities in Hong Kong and Shenzhen, 65 International Journal of Technology Management, 1, 2014, available online.

Appendix II: Details for the Costing of Qianhai Scheme

In this appendix, we want to provide more details about our back-of-the-envelope costing of the Qianhai project – and the cost of various components of the project. We take as the basis of our calculations a planned surface area of 15 km^2 and 13,000 per square meter (or total population of 225,000). We also take a budget for infrastructure over the three stages of Qianhai's development at RMB68 billion (or about US$11 billion), with total developable floor area of 26 million square meters, including 12 million square meters for office use, 3.6 million square meters for commercial use and 6.5 million for residential use. Figure D1 shows the planned layout of of Qianhai. and some facts we use in this section.

Figure D1: Planned Lay-Out for Qianhai



surface area	15k km^2	commercial developable area	3.6 million m^2
total budget	US$11 billion	residential area	6.5 million m^2
population per m^2	13,000[259]	cost per m^2	$5,000
developable floor area[260]	26 million m^2	average number of floors	20 floors
total area developed	260 million m^2	total value of real estate	$1.3 trillion
Nanshan's GMP	$53 billion	rental cost	$1,000 m^2
sidewalk costs	$50 linear meter	rail cost	$40 million km^2
road costs	$60,000 m^2	total population	225,000
number separate property units	56,000		

[259] Shanhai has a population per square kilometre of 13,400, Beijing 11,500, and Shenzhen an overall population per square kilometer of 7,500. As city planners have designed Qianhai to serve as a high density commercial and residential area, the use of 15,000 does not seem exorbitant. The maths of 15 times 15 also produces easier to work with numbers.

[260] Read more at http://www.squarefoot.com.hk/news/372/qianhai-rises-as-shenzhen-new-cbd/#W50kJJG5CBfIIX9I.99

Before we start with our calculations, the reader should keep four points in mind. First, the values we use represent simple round-figure estimates – to show the logic of the calculation without getting bogged down in imprecisely minute estimates. Second, any reader wanting to make their calculations by changing our cost assumptions need only plug the new number into the text below. We write out (in words) the mathematical formula in cater to readers who feel uncomfortable with equations. Third, our objective is not to arrive at an accurate estimated cost of Qianhai. Instead, we want to assess the magnitude of these costs. If the government has set aside $11 billion for infrastructure (for example), is it too much or too little? We hope our calculations help hone yours and our intuitions about the magnitude of these costs. Fourth, we use US dollars as a basis for calculations rather than RMB. In a highly distorted economy like Shenzhen's, prices of inputs may vary (due to administratively set prices, monopoly/monopsony power of government-owned/run businesses and so forth). Readers interested in seeing the original list should see http://qhsk.china-gdftz.gov.cn/en/POLICY/Comprehensive/201506/t20150623_17270357.html

We have two final caveats to share with our readers. First, we should warn readers that this is not a dissertation in project management. As such, we do not provide the kinds of detail a person reading a project management report might expect. Second, the various Qianhai action plans and regulations repeat themselves often. For example, plans for promoting Qianhai as a logistics hub appear at least 6 times – in differently worded sections. Thus, we lump these together rather than breaking them down into sub-components.

Development of Information Services Industry

(1) Develop high-level information transmission service industry (piloting the "integration of 3 networks".

We assume the placing of mobile phone towers, fiber optic cable and 2 organisations dealing with this work – a private sector company in charge of providing such connectivity and a government body responsible for regulation and inspection. Assuming a cost of $500 million per building and a staff of 2,000 people (earning about $40,000 per year), and roughly $20 million for equipment (based on estimates from other neighbours world-wide for which information is available online), we arrive at $680m for the first 2 work-years.[261]

Promote the cooperation between network operator, media companies and value-added service providers, Enhance the cooperation between Mainland and Hong kong telecom operators to explore new business opportunities.

Such cooperation would likely involve 60 staff working for 6 work-months on each deal. Taking only their salary as a cost, the cost comes to around $1.2 million.

[261] We define a work-year as 250 days of work, divorced from calendar time. In that way, we can block time into discrete chunks without complicating the analysis with stoppages.

Focus on the development of Internet value-added services and mobile communications value-added services, attract excellent value-added service providers, content providers and system integrators from home and abroad to settle down in Qianhai.

We assume that 20 people will work on this innovation for the two year period we look at. Thus, total spending on these staff (without adding over-head costs for electricity, office space, etc.) comes to around $1.6 million. Our calculation does not depend on whether these workers are successful or not.

(2) Vigorously develop software and IT services.

Encourage the development of system integration, information technology consulting and operational services.

We assume that for Qianhai's expected population, these IT staff come to around 5,000 for a total 2 work-year cost of $400 million. We do not add the costs of advertising positions abroad, expat allowances and so forth.

Robustly develop technologies such as high trusted computing, intelligent network technology, cloud computing and explore their applications...[and] accelerate the cluster development of software industry.

Roughly 500 workers working with technology of $12,000 per person – yielding a two work-year cost of $52 million.

Promote the construction of the Shenzhen-Hong Kong branch of Shenzhen Software Park in Qianhai (forming a software and information services park with significant impact).

Assuming a park with 1,000 workers in 20 buildings with surrounding infrastructure (roads, electric lines, etc. on a per building basis of $1m for each $30 million building) gives a total estimate of $970 million.

Development and application of industrial application software will be promoted, in order to create comprehensive advantages for software industry to provide system integration and industrial solutions service for logistics, finance and other sectors. Accelerate the development of mobile e-commerce, mobile multimedia, mobile search, mobile payments and other new businesses.

We lump industrial software and ecommerce together as both require well defined sub-industries. If both areas require 250 workers (researchers, salespersons, admin, managers, etc.) and equipment of $5,000 per person, the total cost comes to 22.5 million for 2 work-years.

(3) Building a logistic information exchange hub and an international e-commerce center in southern China..[and].. Build a standard system for Shenzhen-Hong Kong logistics information classification and coding, collection, exchange and security; enhance logistics information resources sharing among the transportation, customs, banks, the industry & commerce department, the tax department and other relevant departments; establish a logistics public

information platform; start a southern logistics information exchange centere...[and] Encourage logistics enterprises to improve the research and development of new technologies in intelligent transportation and logistics management applications, in order to innovate and improve their operational management level.

We assume the information hub would be an online research and the e-commerce centre just another office building. We further assume that the information hub would take 3 man-months to complete (design, coding, testing, etc.) – without any additional capital expenditure. We also assume that the office building would cost $30 million (based on similar property transactions). We assume that the costs of employment are borne by the companies occupying the e-commerce centre. Thus, the total cost of this item comes to $30 million (and $20,000 for the programmer's salary).

Support the R&D and industrialization of key Internet of Things software, in order to speed up its development.

We assume such support would consist of support for R&D (researchers and equipment). Such support could be conceived as hiring researchers in the public sector, giving grants to private companies for such innovation, etc. We assume a budget of 5 work-year equivalents (namely the value that five people would earn over 5 work-years).[262] Thus, these resources come to only around $200,000.

Accelerate the establishment of a security certification system for digital certificates; promote the application of digital signature and certificate in logistic information exchange and e-commerce. Vigorously develop e-commerce and build a safe, convenient and multi-currency compatible business transaction service platform. Enhance the connection with major international e-commerce platform and develop Qianhai into an international e-commerce hub.

We assume that this vacuous statement requires the same support as the last point above (namely just coding software and the related activities – like dealing with current and potential clients, management, etc. We thus tally these activities at another $200,000.

(4) To develop content services. Develop data analysis and consulting services, and actively introduce international high-level data service companies into Qianshan; cultivate local enterprises and bring them to the international level; construct a regional data analysis and consulting service center.

We treat this as the previous two policy objectives – namely just supporting the coding software. We assume the Qianhai government will not want to run their own consulting service centre – but instead facilitate private sector work on the centre. Thus, as with the previous points, we assume a cost of $200,000.

Develop a new integrated media of broadband communications technology, mobile multimedia broadcasting and digital television. Strengthen the development and utilization of Internet digital

[262] The actual form of the funds used could vary – such as grants to companies. Therefore, we report this amount in salary terms to match the other analysis in this section.

content services, in order to attract prominent Internet companies to set up headquarters, regional headquarters in Qianhai.

Ditto – for a value of $200,000.

Develop Qianhai's competitiveness in online game, online music, online video, online media and online advertising. Organize dedicated projects for developing advanced mobile Internet content products, online game engine and platform. Actively develop derivative products and services, e.g., web content, animation, games, and etc., and promote the development of related industries.

We assume Qianhai planners will see that the market for gaming/music is not something that can be centrally planned. As such, the most support they can provide is to give start-ups free (or discounted) office space and even help out with salaries. We do not include any wage support. Assuming that Qianhai authorities support 50 companies with 5 staff each and our assumed real estate value gives us an estimated cost of $5 million for 2 years of rent assistance.

Prioritize the development of technological innovation services in order to meet the need of innovation in the Pearl River Delta, the cooperation of technological service between Shenzhen and Hong Kong should be promoted.

This statement is vacuous (at least more so than the other mostly vacuous statements in the Qianhai plan).

The scientific and research institutes in Hong Kong should be assisted in setting up affiliates in Qianhai and participating in dedicated technological projects at both national and regional level. New models of fiscal support for Shenzhen-Hong Kong technological innovation service should be explored.

As before, we assume that such assistance will consist only of cash payments to institutes and companies (thus the words "fiscal support"). If past trends reflect the future, we expect roughly $5 million in such support.

Support the development of Shenzhen-Hong Kong cross-border inspection and detection service and explore the new model of customs supervision and control to provide convenience services for technological innovation...[and] turn the Qianhai customs into a comprehensive place integrated with customs inspection, traffic hubs and office complexes based on the western express rail between Hong Kong and Shenzhen and the building of navigation towers in Qianhai.

Based on customs support projects funded by international donors (as we do not have internal expenditure data from customs agencies themselves), we expect this support would require $2 million for the advisory work and about $10 million for the building works – or $12 million in total.

Vigorously develop high-tech service, support the establishment of technological transfer platform and venture capital platform, and encourage the establishment of technological service institutions for technology evaluation, ownership exchange, and product industrialization.

Vacuous.

Support services such as R&D, industrial design and analysis test. Facilitate the development of Shenzhen-Hong Kong innovation circle and promote the technological transfer and product industrialization in the Pearl River Delta.

Given expenditure on these innovation circles in the past, we expect a possible $2 million in funded earmarked for these goals.

(2) Vigorously develop creative design service. Give full play to Shenzhen as the design center, and formulate a guiding directory for creative industries to be developed by Shenzhen and Hong Kong jointly. Build a high-level creative industry park which can represent the direction of future industrial development, in order to attract well-known design institutions and well-established intermediary service institutions for cultural industry both at home and abroad. Promote the development of creative industry to make Qianhai an international center for creative industry.

As in the previous points, we assume such support will consist of the building of an office complex and wage support (even it is in the form of extra government/bureaucratic jobs to write policy documents). The total cost would come to around $50 million (with wages making up a tiny fraction of this amount).

(3) Actively develop professional service. Lift the restrictions on market access and empower the local administration with the approval authority. Actively develop high-end services such as planning, certification, management, strategy development for enterprises, enterprise image design, marketing & branding, as well as convention & exhibition services. Facilitate the development of human resource service, construction and engineering service and health care service. Assist the service providers from Hong Kong in setting up professional service institutions in Qianhai in the form of single ownership, joint venture or partnership, in order to provide customized and high-end professional services. Conduct research on how to optimize the review and approval procedure, shorten the time for the procedure and develop accounting and legal services.

We assume that all this consists of pushing papers around. If 5 staff work 5 work-years, the cost comes to $1 million.

1. Development of traffic facilities. Establish the regional highway system based on the Guangzhou-Shenzhen Pearl River High Way-Hong Kong-Shenzhen Western Corridor, Guangshen Expressway, Airport-He'ao Expressway and Shenzhen-Zhongshan Pearl River Channel. Carry out the planning and construction of Nanping Expressway and costal avenue and strengthen the traffic links between Qianhai and other important areas in Shenzhen...[and] Optimize and improve the urban roads. Build a high-standard arterial highway network, and a high-density internal lane network, and improve the level of road landscape design.

If we assume that the government ends up paying for only 50 square kilometers – the cost comes to $3 million.

Conduct the preliminary work of interconnection between airports in Hong Kong and Shenzhen to strengthen the traffic link between Hong Kong and Pearl River Delta in Qianhai based on the planning and construction of the intercity rail between Huizhou, Dongguan and Shenzhen.

If we assume the rail run for 3 kilometers and using our assumed cost, the total cost comes to $180 million.

Prioritize the development of public transport and vigorously develop conventional public transport with rail traffic as the backbone. Build the supporting transfer station for public transport and strengthen the connection between rail traffic and conventional public transport to achieve "0-distance connection".

We assume the government will support the creation of 2 transfer stations (basically just a place to park buses and seats for people to wait) as well as put 10 more buses on the road and 2 more rail service times. Under these assumptions, the total cost would come to $8 million.

Optimize and improve the slow-walk system and develop high quality walking space.

We assume the government would need to pick up these costs (as private sector actors would not want to finance unprofitable land). For roughly 5 km of such walkways, the total cost comes to only around $250,000.

2. Development of important municipal facilities. Based on the principle of supplying water of different quality for different purposes, plan and build the water supply network in Qianhai and provide high-quality drinking water. With the second phase project of Nanshan sewage treatment plant, build sophisticated sewage treatment facilities and recycled water reuse system in Qianhai.

The cost of an 380,000 meter cubed treatment facility comes to around $100 per cubic meter. Pipes cost about $3,000 per flat (or double that for standalone properties) for 56,000 residential units and business units with running water. The total cost for 2 plants and the pipes comes to $38 million plus $168 million or around $200 million in total.

According to the standard of controlling the worst flood and tide in 100 years with drainage channels and controlling the worst flood and tide in 200 years, improve the overall ability of flood and tide control.

At $50 per meter and 5 kilometers of such drainage comes to only $250,000.

Plan and build a system of energy-conserving with centralized electricity supply and energy safeguard, and carry out the development of smart power grid.

This item comprises much of Qianhai's budget. Reports from Europe put the cost of a 600 megawatt plant and associated grid at $2 billion.

Build high-standard information infrastructure. Actively develop TV broadcasting network and internet of the next generation. Facilitate household connection fiber and promote 3G network. And build international standard internet, communication network and broadcasting network.

Facilitate the joint development and sharing between information infrastructure and other facilities.

The cost of laying cable (on average) comes to around $120,000 per kilometer. For 25 kilometers of cable in and around Qianhai, the cost comes to around $3 million.

3. Ecological and environmental protection. Form an ecological green corridor based on three rivers, namely Shuan Jie River, Gui Miao Canal, Chan Wan Canal, by making full use of Danan Mountain, Xiaonan Mountain and Qianhai costal line. Rigorously carry out environmental function zoning and water function zoning. Develop strict environmental standard for construction projects.

We assume that these costs comprise simple planning and study. If 10 people work 2 man years, the cost comes to a tiny $800,000.

Reinforce the pollution treatment for various water bodies in Qianhai Bay. Continuously improve the water quality and air quality in Qianhai Bay to upgrade the environmental level in Qianhai.

We assume an average cost of pollution mitigation equipment for water treatment plants and at factories/electric facilities of $200,000 per unit for 500 units, for a total of $100 million.[263]

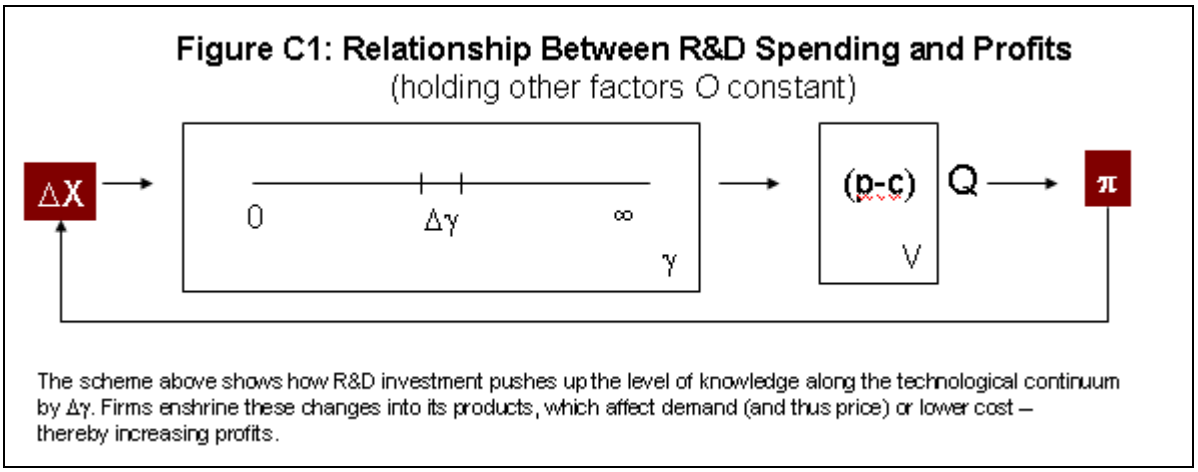
Vigorously develop green traffic, green construction and actively promote projects of renewable energy, water conservation and water cycle, in order to turn Qianhai into an energy-conserving area with low energy consumption, low pollution and low carbon emission.

We assume this activity costs of social advertising (propaganda) – with similar initiatives in other cities cost around $200,000.

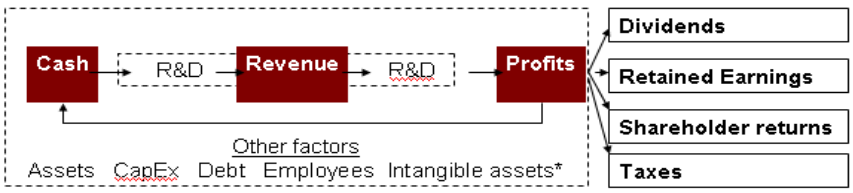
[263] We have broken treatment costs for water and air into per unit costs and averaged them – creating the cost of a hypothetical device – in order to arrive at a simple and transparent figure to use in our calculation.

Appendix III: Overview of the Model of Innovation-Led Profitability Model for Qianhai

Our model follows the typical structure of a firm's balance sheet. Suppose that Hong Kong's *i* firms and Shenzhen's *j* firms make up Qianhai's total firms (at least in the short-run) of $n=i+j$ firms. These firms produce a non-descript product valued at $V=n(pQ)$ – where we can model these *n* firms as producing *Q* of this "representative product." Figure C1 traces out how R&D spending affects other variables in our model. We model the finance of innovation as a change in R&D spending (ΔX). Such a change thus gives the firm making the ΔX R&D investment a slight nudge on the "technological continuum" of potential future advances.[264] Such that a firm invests money into R&D in order to lift the "knowledge-level" – thereby increasing the value (to the consumer) of the products it makes (O'Donoghue and Zweimuller, 2004). If the knowledge from this continuum (γ) goes into producing goods and services valued at *p* and *c*, then a change $\Delta\gamma$ leads to a slight change in the value of these goods (where value *V* simply reflects the benefit to the consumer minus the cost of production).[265] The sale of these innovation-laden goods and services thus produce profits – some of which firms use to fund new R&D in the next period.



$$\begin{bmatrix} K \\ X \\ \Pi \end{bmatrix} = \begin{bmatrix} \alpha \Pi^{a} O^{b} X^{c} \\ \beta K^{d} \Pi^{e} \\ \gamma O^{f} X^{g} \end{bmatrix}$$



Set of model variables. We use a set of three kinds of variables. The main variables of interest $\{K,X,\Pi\}$ representing capital/cash, R&D spending, and profits respectively. The letters *a-g* represent the usual effect of each of these variables in the equations shown in the lower-left part of Figure C1. Variable *O* represents other traditional factors which affect our model's variables...like employment. Confirmatory variables *C* do not appear in our model – but appear in

[264] In this almost 30 year old view of innovation, a stock of innovations lies in wait – such that investment in R&D provides access to a slightly more knowledge on this continuum. Strulik (2005) provides a competent overview of the relevant literature.

[265] Such a formulation for value allows R&D to affect both an innovative firm's product and process – which matches our model shown in the previous section. As such, a change in γ can increase prices paid by customers or decrease costs of production (or both).

our econometric work to confirm or question our analysis. These variables include factors like tax payments and shareholder returns.

Definition and behaviour of *O*. In this model, we treat the numerous factors we used in our empirical work by a simple aggregate factor *O*. To derive *O*, we might think about a constructed variable which takes on both the mean and variance properties of its components so as to reflect the combined change in these other variables in this new variable. Equation (1) shows a possible weighting scheme for *O* – which takes the mean and variances of these variables into account. Such a variable *O* at time *t* would thus equal,

$$O_t = \left[\sum_{i=1}^{n} (\alpha_i E(X_i) + \beta_i \text{ var}(X_i)) \right]_t \qquad \text{for } i=(1,6) \qquad (1)$$

where X_i consists of the value (in Hong Kong dollar terms) of total current assets, total assets, capital expenditures, long-term debt, employees, and intangible assets. In this case, *x* does not represent R&D spending (and we use *x* only for illustrative purposes).

We have thus chosen the simplest possible model for our purposes. Our model consists of the geometric relationship between three endogenously determined variables (*K*,*X* and *Π*). As Sener (2008) notes in his review of the literature, the size of R&D, production, research and so forth matters very much for product/service use and profit. D'Aspremont and co-authors (2009) though that size effects might change – such that some parts of "bigger" don't necessarily mean better. Yet, even simple models like Leppala (2015) – show the difficulties of including spill-overs between firms and regions in a modelling framework. A game-theoretic approach ideally suits our own project – of looking at the "game" between Hong Kong and Shenzhen companies/governments in maximising the profit from innovation. Yet, even simplistic extensions – along the lines of Kaiser and Licht{1998} would make our work exceedingly complicated. Yet, how likely are these assumptions to actually cause significant problems in our model?

Figure C2 explicitly shows the possible spill-over effects and the parameter values enshrined in the assumptions we make in our own study. While we do not cling to our assumption about the geometric specification of our model, we do cling to assumptions about the lack of spillovers. We thus use the symbol ○ to denote an operation (addition, multiplication, etc.) to account for the various functional forms we test in our own econometric work. The first assumption simply notes that a firm's profits derive from some combination of its own R&D spending, cash (available for other types of activities), as well as R&D/cash from competing/cooperating firms in Hong Kong and in Shenzhen. The second condition notes that R&D spending consists of some function of profits and other cash available. The third condition notes that R&D spending depends on only the firm's own profits and cash. The fourth condition notes that cash depends only on the firm's own action. The last two conditions simplify our model's world – by excluding the possibility of distortionary finance (affecting research incentives for example) and crowding out in R&D markets.

Figure C2: Spill-over Conditions and Assumptions Used During Modelling

1. $\pi_i = f_i(K,X) + f_{i'}(K,X) + f_j(K,X)$ such that $f_{i'}=0$ *and* $f_j=0$ and
2. $g(X_i) = \alpha_1 g(\pi) \circ \alpha_2 g(K)$ such that $\alpha_1 \geq 0$ and $\alpha_2 \geq 0$.
3. $f(X_i) = f(\beta_1 \pi) \circ f(\beta_2 X_{i'}) \circ f(\beta_3 X_j)$ such that $\beta 1=1$, $\beta_2=0$ *and* $\beta_{3j}=0$ and
4. $f(K_i) = \beta_1 f(\pi) \circ \beta_2 f(K_{i'}, X_{i'}) \circ f(\beta_3 f(X_j, K_j)$ such that $\beta_1=1$, $\beta_2=0$ *and* $\beta_{3j}=0$ and
5. $X_i \neq f_i(X_{i'}, X_j)$ non-distortionary finance rule
6. $\Delta f_i(K,X) - \pi_i > 0$ no crowding out

Assumption 1: Policymakers in Hong Kong and Shenzhen have the authority and desire to create a Qianhai region if such a structure increases their companies' profits.

Our model predicts – and relies on – Hong Kong and Shenzhen policymakers adopting many of the recommendations we provide, if these recommendations prove advantageous. Yet, with the many policy and personal objectives policymakers in the Qianhai region have, how can we ensure that profits – rather than innovation/R&D for its pure sake – represent policymakers' true desired maximand?

In the context of our model, equation (2) shows that policymakers would support the Qianhai project if if the inequality in the equation holds. Simply put, the values of *K*, *X* and especially Π must exceed those of the sum of Hong Kong and Shenzhen separately. Such a condition necessarily implies that $\left[\alpha \Pi^a O^b X^c\right]_{QH} > \left[\alpha \Pi^a O^b X^c\right]_{HK} + \left[\alpha \Pi^a O^b X^c\right]_{SZ}$. If we denote the profits of innovation-led companies in Qianhai (or use QH as the acronym for Qianhai) for example as Π_{QH} and the parameter of *a* for Qianhai firms as *a*(QH), then Qianhai firms will attract more cash to the extent that their variables and parameters are "higher" than those in Hong Kong and Shenzhen added together. As shown in equation (3), each and every variable and parameter need not be higher (so $(X_{QH} > X_{HK}) \cap (X_{QH} > X_{SZ})$ and/or $(c(QH) > c(HK)) \cap c(QH) > c(HK))$. While each term for Qianhai need not exceed those in Hong Kong or Shenzhen, some function *f* must guarantee that the overall effect of their joint effect on K exceeds the joint effect *f'* of similar variables for Hong Kong and *f''* for Shenzhen.

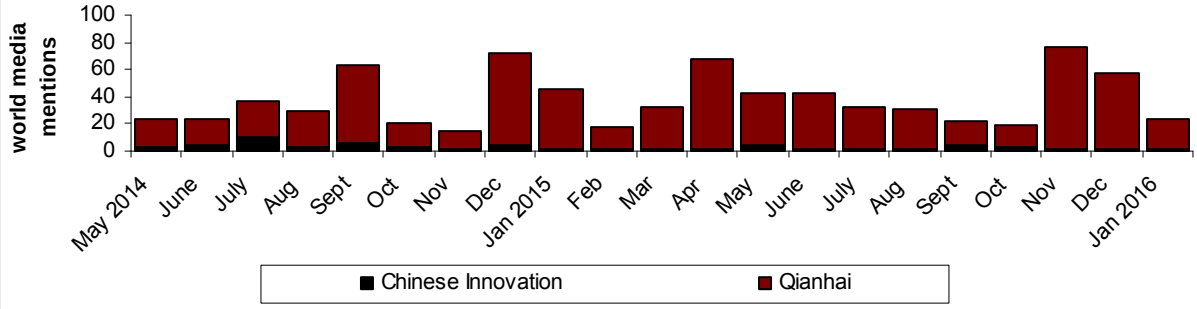
$$\begin{bmatrix} K \\ X \\ \Pi \end{bmatrix} = \begin{bmatrix} \alpha \Pi^a O^b X^c \\ \beta K^d \Pi^e \\ \gamma O^f X^g \end{bmatrix} \begin{bmatrix} K \\ X \\ \Pi \end{bmatrix}_{QH} \geq \begin{bmatrix} K \\ X \\ \Pi \end{bmatrix}_{HK} + \begin{bmatrix} K \\ X \\ \Pi \end{bmatrix}_{SZ} \tag{2}$$

$$f(\alpha_{QH} \Pi_{QH}^{a(QH)} O_{QH}^{b(QH)} X_{QH}^{c(QH)}) > f'(\alpha_{HK} \Pi_{HK}^{a(HK)} O_{HK}^{b(HK)} X_{HK}^{c(HK)}) + f''(\alpha_{SZ} \Pi_{SZ}^{a(SZ)} O_{SZ}^{b(SZ)} X_{SZ}^{c(SZ)}) \tag{3}$$

Because we focus specifically on profits, Hong Kong and Shenzhen policymakers must prefer some function $f_{QH}(O,X,K) > f_{HK/SZ}(O,X,K)$ for the *i* or *j* firms from their jurisdiction which produce O,X,K. Policymakers must thus prefer such a function—which we already know corresponds to profits. As we already know $f(O,X,K) \equiv \gamma_{QH} O_{QH}^{\ f(QH)} X_{QH)}^{\ g(QH)}$.

Numerous empirical sources indicate that policymakers in the Qianhai region will prefer profits – rather than innovation and R&D for its own sake. Figure C3 illustrates the importance of the Qianhai project to policymakers and their peers. The figure specifically shows the frequency of mentions in the global media about Qianhai and Chinese innovation more generally. From May 2014 to the beginning of 2016, the world media referred to "profitability" and "China" 10,735 times. They referred to Qianhai 732 times and to "Chinese innovation" only 61 times. Such data does not constitute a proof. Yet, they show -- through an informal type of "revealed preferences" – that policymakers place some importance on the profitability of the Qianhai project.

Figure C3: References to Qianhai Exceed those of Chinese Innovation by almost Factor of 10 Showing Policy Commitment to Profitability



The figure shows, by way of illustration the importance officials place on Qianhai's success -- as measured by media citations. Source: Factiva (2016).

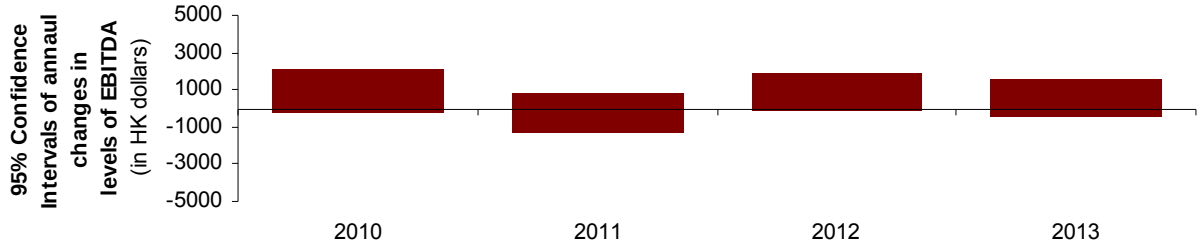
Assumption 2: Stable relationships between our model variables exist – making the recent past an adequate basis for policy recommendations about the future

Such an assumption corresponds with the following case. Suppose we establish the case corresponding to equation (2) for time *t* (for 2009-2015 for example) for functions *f(X,P,K,O)*, *f'(K,P,X,O)* and *f''(X,P,K,O)*. Now suppose that these relationships changed, such that $f_1(X,P,K,O)$ --> $g_2(X,P,K,O)$, such that the value returned from $g_2 < f_1$. If $\alpha g_2 = f_1$, such that $\alpha > 1$, then $\Pi_{2QH} < \Pi_{1QH}$. If ε represents the expense of encouraging firms to move/expand into Qianhai, then policymakers would lose $\varepsilon n(g_2 - f_2)$, where f2 represents a counter-factual (hypothetical) case of the profits these *n* firms would have earned had they not expanded/moved to Qianhai.

We have shown in the statistical appendix that profits, R&D spending and other variables analysed in our study have remained relatively stable over time. Figure C4 reproduces the range of profits reported by firms in the Qianhai region for the last 4-5 years. Financial crisis may occur at any time. Yet, the most likely outcome consists of the ongoing stability of these profits (at least

in the short-to-medium term). Such stability continues – even through a raft of new laws and policy initiatives aimed at promoting the Qianhai region.

Figure C4: Changes in Profits (and other Variables) Stable Over Time
(suggesting past trends will carry into the future?)



The figure shows overlap in the 95% confidence intervals of mean EBITDA -- suggesting that (before considering the effect of exogeneous variables) the processes determining profit will likely remain stable enough over time for our model to make useful predictions. The data show differences in the levels of EBITDA for Hong Kong and Shenzhen taken together (with similar trends for each jurisdiction separately). For readers loving statistics, an F-test asking if the mean of any year differs from zero (or from each other) comes to $F(4, 138)=.55$ with a probability of similar means come in at around 70%.
Source: based on data by Compustat (2016).

Assumption 3: Qianhai represents either a positive or negative "expansion" of existing business activities in the constituent jurisdictions – without any inter-sectoral twisting (ie. one sector harmed at the expense of another's gain).

Suppose that, contrary to our first assumption from Figure C2, profits for firm *i* depended on cash and R&D in another firm. As $f_{i'}(K,X)$ and $f_j(K,X)$ by definition represent a function of profits, then equation (4) shows how firm *i*'s profits depend on its inputs and other firms' profits. Assuming for simplicity that all firms are basically alike, and that they choose *X, K* and ultimately their π the same way, then these choices can increase firm *i*'s profits (up to some limit *a*) or decrease them (by *–b*), where *a* and *b* represent monetary figures in Hong Kong dollars. As such, $h_{i''}(\pi_{i'}) = f_{i'}^{-1}(K,X)$, such that *h* represents the way other companies' profits affect firm *i's* profits. Equation (5) shows negative profits in the case that firm *i*'s own profit-creating *X,K* decisions do not exceed the profit damaging decisions of *h(i')* and *h(j)*. Because of our identical firms assumption (for this illustration), Equations (6) provides the minimum and maximum profit that firm *i* can expect. Thus, profits range from $-2b\pi$ to $\pi(1+2a)$.

$\pi_i = f_i(K,X) + f_{i'}(K,X) + f_j(K,X)$ that $1 > f_{i'} > 0$ *and* $1 > f_j > 0$.

$\pi_i = f_i(K,X) + h_{i'}(\pi_{i'}) + h_j(\pi_j)$ $\quad -b > h_{i'} > a$ *and* $-b > h_j > a$ (4)

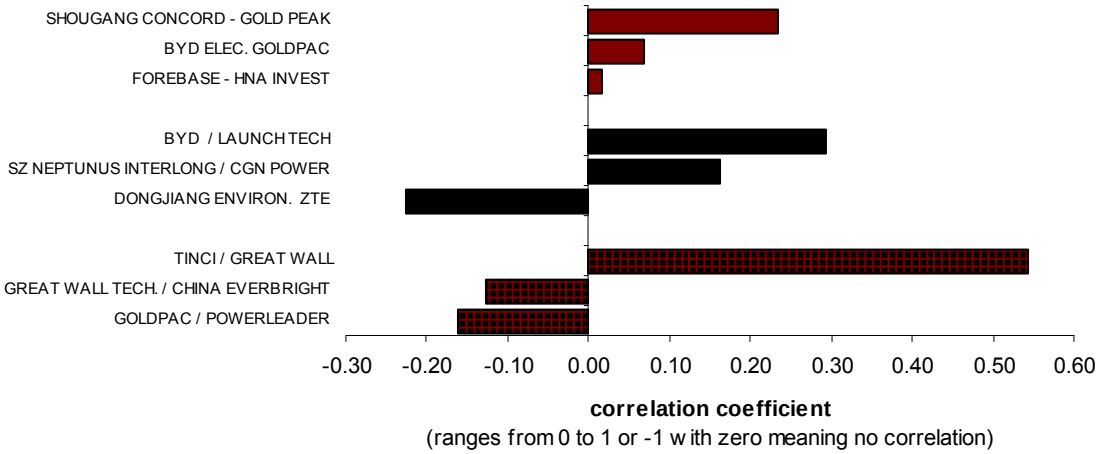
$\pi_i = f_i(K,X) + h_{i'}(\pi_{i'}) + h_j(\pi_j)$ $\quad 0 > f_i > 1$, $-b > h_{i'} > a$ *and* $-b > h_j > a$ (5)

$\pi_{\max} = \pi + 2a\pi = \pi(1+2a)$ and $\pi_{\min} = -2b\pi$ (6)

if π_{max} $f_i=1$, $h_{i'}=a$ *and* $h_j>a$ and π_{min} $f_i=0$, $h_{i'}=-b$ *and* $h_j=-b$.

The data also support this non-rivalry assumption. Figure C5 shows the average correlation among all the variables we look at in our study between companies in our sample.[266] Our model required rough independence between firms – as strategic interaction between firms would add an important dimension to innovation which our model does not capture.[267] The low average correlation coefficients shown in the figure thus suggest that our model variables – rather than strategic interaction – likely affect profits, R&D, and cash in the Qianhai region.

Figure C5: Assumptions Abou the Independence Between Qianhai Regional Firms Reasonably Justified in the Data



The figure shows the extent to which financial outcomes of one firm depend on another. High correlations would point to spill-overs (in innovation or otherwise) between firms in the Qianhai region. These data show relative independence between firms (as assumed in our model) - with only the Tinci/Great Wall correlation looking rather high. We calculated these figures by chosing three pairs of companies at random -- and taking the correlation coefficient of the data for similar years. We then find the average correlation of these roughly 12 variables, which we report above.
Source: based on Compustat data (2016).

Such an assumption clearly represents the Achilles heel of our model in the longer-term. Growth in the Qianhai region will likely entail the significant dislocation of resources – as some companies grow in their niche at the expense of others. Luckily for our model – if not unluckily for the local economy – policymakers have tended to prevent the economic dislocations (through market management) concomitant with rapid innovation-led growth (Sharif, 2012). Science park-led development and innovation – at least for now – has not produced the sweeping changes seen in the US, UK and elsewhere (Cheng *et al.*, 2013). If we might rely on the past, our assumption of non-rival profitability should hold in the medium-term.

What about the way that policy can change the model parameters themselves. Figure C6 illustrates many of the policy proposals we have given in this paper, lists the parameters these policies would most likely affect, and shows the reasons why these changes might occur. For example, increased use of Hong Kong law for Qianhaiese-related contracts would increase the

[266] For example, for two companies we compare at random, we look at the correlation coefficient for total assets, for current assets, EBITDA and so forth for the 12 variables we collected data about. We averaged these correlation coefficients – and report these averages in the figure.
[267] We described such strategic considerations – and evidence for or against – in our literature review.

profitability of employing more "other" factors of production and conducting more R&D. Thus, by altering the value of these variables and parameters, we can assess the likely effects of the Qianhai project.

Figure C6: How Do Our Legal Proposals Likely Affect the Model's Parameters?
(under assumption that policy changes does not decrease parameters from current values and the benefit of all proposals measured in comparison with status quo)

	α	β	γ	a	b	c	d	e	f	g
Use of Hong Kong law and courts in SZ	1	2							3	4
Performance-based appraisal for innovation funding							5	6		7
Privatisation of Qianhai authority	8	9	10	11	12	13	14	15	16	17
Stock Connect		18					19	20		
Joint research investment vehicle	21	22				23	24			25
Patent reform	26	27		28		29	30	31		32
Business-Uni collaboration (tax break and authorisation)							33			34
New Chinese paid-for infrastructure					35	36	37		38	39
Reforming SIRI	40	41				42				

The figure shows which of our policy/legal proposals which impact on which of our model's parameters. Each number in the figure refers to a footnote which describes the relationship between the legal/policy change and the parameter in more detail. The figure refers to parameters in the following three structural equations: $K = \alpha \Pi^a O^b X^c$ $X = \beta K^d \Pi^e$ $\Pi = \gamma O^f X^g$.

Reasons

Use of Hong Kong law and courts in SZ

1. HK law encourages more investment for every unit change in other variables (as investors have more confidence in getting their money back, etc.).
2. R&D rises because investors more certain they can recover benefits of profits and investment.
3. HK makes other investments (capex, etc.) more profitable due to more secure property rights.
4. HK law makes R&D spending more profitable due to less dissipation (insecure property rights)

Performance-based appraisal for innovation funding

5. Performance objectives for innovation agencies makes sure their money actually goes to better R&D
6. Performance objectives mean that more profitable companies do more R&D (as this is an explicit performance target as described in the main paper).
7. Performance targets increase R&Ds impact on profitability (otherwise funding agency axed).

Privatisation of Qianhai authority

8. A results-focused Qianhai crowds in (encourages) other investments and reinvestment of profits to get more funding (from government and from outsiders).
9. Qianhai's mandate is to facilitate R&D (offering ways of spending more and better on R&D),
10. A private Qianhai would need to make profits (or go out of business).
11. a private Qianhai would have stronger incentives to use existing profitability of its portfolio as selling point to encourage foreigners to give money,
12. Private Qianhai would use money far better than administrative body
13. ditto (private Qianhai uses R&D on its roadshows)
14. A private Qianhai will have stronger incentives to get its portfolio companies to invest their own money into R&D (instead of waiting for government hand-outs),
15. ditto (less incentive to take out profits to make owners even more personally rich),
16. a private Qianhai authority will more closely ensure spending feeds into profits (instead of patronage, etc.),

17. a private and strong Qianhai can help raise the profit impact of R&D spending.

Stock Connect

18. Stock connect makes more resources available, so that firms can worry less about capital constraints (and thus use more money for R&D),
19. Stock connect would channel more money into companies (and thus their R&D programmes),
20. Larger profits give stronger incentices to do R&D (as their share price rises and more investor money comes in),

Joint research investment vehicle

21. Such vehicles would allow companies/universities to use existing results to snag more investment,
22. vehicles targeted at innovation (monetising academic ideas) thus increase R&D money available,
23. vehicles offer a way for R&D spending to translate into more investment,
24. vehicles by logical extension of the above, money into R&D (as they are research vehicles)
25. vehicles have an explicit mandate to turn R&D into profit (whereas in normal business can just turn other expenses O into profits).

Patent reform

26. prestigious local patents would increase investors' interest in their investments – as local patents make the local area more attractive,
27. such patents increase firms' interest in turning money and profits into R&D (and thus IP),
28. patents have been shown to increase investor interest in profitable firms
29. ditto (but interest in R&D holders)
30. patents increase interest in using cash for R&D
31. patents encourage companies to use more profits for R&D
32. patents main purpose in turning R&D into profit

Business-Uni collaboration (tax break and authorisation)

33. collaborations decrease cost to business of R&D and increase cash available to universities for such R&D
34. busineses can "outsource" the cost of R&D, making their partial spending more profitable on a per-dollar basis.

New Chinese paid-for infrastructure

35. The Qianhai spending proposals encourage investors, making already existing levels of capex and other spending even more attractive to investors.
36. Qianhai spending on "public" R&D have multiplier effects on private R&D – making private R&D more attractive to investors (who freeride on the benefits of the public part of the R&D).
37. Government infrastructure spending (as noted above) decreases the need for private R&D spending, making such funding go farther in terms of funding R&D.
38. Public spending (on business parks etc.) offsets some costs companies would otherwise need to bare privately – increasing profits.
39. ditto (public spending makes R&D more profitable as investors grab externalities and dont pay full cost of inputs as taxpayers).

Reforming SIRI

40. SIRI's whole mandate is to increase the value of alpha (beta and c), so if it doesn't – it has failed.
41. see above
42. see above.

The Qianhai project – at least in our model – depends on three major factors. Policy can affect these variables and the parameters that guide how they grow the local economy. We use data from Hong Kong and Shenzhen to populate our model – and use math to figure out how the changes we propose might affect growth in the Qianhai region.

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Appendix IV: Statistical Modelling of the Qianhai Innovation-Led Profitability Model

Variable definitions and summary statistics

Most studies look at the effect of R&D or economy integration on some proxy for innovation. Our study though aims to assess the extent to which R&D passes through to profit – on the understanding that larger profits attract the capital that will help Hong Kong develop as an international financial centre. Companies innovate to make profits, not simply to do more R&D or score more cash. Figure D1a shows the main variables we used in our study. We used Compustat data for Shenzhen and Hong Kong, from 2009-2014. Figure D1b shows the exchange rates we used to convert financial statements given in RMB or dollars into Hong Kong dollars. Given that we have three endogenous variables which affect each other (R&D spending, EBITDA as a proxy for profits and "cash" or money these companies have available for investing), we needed system-based methods of modelling and estimation. R&D spending both determines EBITDA (profit) and profit provides much of the resources for R&D. **Even a cursory glance at the variables shows the need to overcome very serious endogeneity between variables.**

Figure D1a: Variables Used in Qianhai Innovation Study

Endogenous variables			
R&D	**EBITDA**	**Revenue**	**Current Assets**
Exogenous variables			
Total Assets	**Capital Expenditures**	**Long-Term Debt**	**Dividends**
Employees	**Intangible Assets**	**Retained Earnings**	**Income Taxes Paid**
Common Shares outstanding	**GIC Group**	**City**	
Constructed instruments			
"Pure" Profit	Represents the residual of EBITDA regressed on year, total assets, capital expenditure, long-term debt, city and GIC group – in order to remove the effects of the latter variables on the former.		
"Pure" R&D	Represents the residual of a regression of R&D on current assets, revenue, city and GIC group – in order to remove the effects of the latter variables on the former.		
"Pure Cash"	Represents the residual of total current assets on year, dividends (as a sign of such "cash"), intangible assets, retained earnings, common shares outstanding, city and GIC group – in order to remove the effects of the latter variables on the former.		

Figure D1b: Exchange Rates Used to Convert All Values into Hong Kong Dollars

Year	1 CNY buys this much HKD	1 USD buys this much HKD	Year	1 CNY buys this much HKD	1 USD buys this much HKD
2008	1.11875	7.78609	**2013**	1.25151	7.75638
2009	1.13305	7.75109	**2014**	1.26126	7.75438
2010	1.14609	7.76822	**2015**	1.24301	7.75214
2011	1.20263	7.7839			
2012	1.22737	7.75667			

The instruments we constructed for the study may require a bit more explanation. Figure D1a above shows the three instruments we constructed, in an attempt to isolate the "pure" part of each variable (namely the part that does not depend automatically by accounting identity on other parts of the balance sheet). Each effect also tries to isolate out the effects of the company's city and industry on its results. Pure profits thus reflect the part of EBITDA which does not depend on cash available (and thus reflects only the effect of factors of production and their factor productivity (which R&D most definitely influences)). Pure R&D reflects only the productivity gains from such investment (controlling for firms which have more cash to invest). Pure cash removes the effects of investment (investor) decisions on cash available. As such, the instrument controls for dividends as well as common shares available.

Even a glance at the study's summary statistics points to several problems which we needed to solve during estimation. Figure D2 shows the summary statistics for the major variables we used in our study – both for each city and for the Qianhai region as a whole. The number of observations for each city "passes" the threshold suggested by the law of large numbers.[268] Yet, Hong Kong and Shenzhen have different numbers of observations, making any cross-city comparisons unbalanced.[269] We have far more confirmatory factors (factors that we do not directly use in our model) than main variables. These factors include the average value of dividends paid, revenue earned, income taxes paid and so forth. We use these factors in three ways. First, we use these data in the section where we describe the nature of competition in innovation-related industries in the Qianhai region. Second, we refer to these data when conducting our econometric analysis – to support our intuitions (or tell why we disbelieve particular results). Third, we use these data ensure that our main variables behave as expected.[270]

Figure D2: Summary Statistics for Variables Used in Qianhai Study
(in thousands of Hong Kong dollars)

Variable	Hong Kong			Shenzhen			All Groups (weighted)		
	Mean	No valid	stdev	Mean	No valid	stdev	Mean	No valid	stdev
Main variables									
Total Current Assets	17,077	159	38,033	17,824	68	28,203	17,301	227	35,316
EBITDA	5,953	159	26,069	1,804	68	3,403	4710	227	21958
R&D Expense	356.53	159	1050.13	1,068.893	68	2633.52	569.930	227	1712.889
Confirmatory factors									

[268] In general, more than 30 observations of many kinds of samples approach a normal distribution – making simple linear regression acceptable for estimation.
[269] Statisticians prefer balanced statistical samples (such that the number of firms from Hong Kong equals the number of firms we analysed for Shenzhen). Given lack of data, we wanted to use all possible data – and rely on statistical methods for dealing with such balancing issues.
[270] Because accounting identities determine the value of so many of these variables – and because reporting omissions and other problems potentially make our data noisy – we can spot data problems if our variables behave in one way but the confirmatory factors behave in a different way. We do not describe in-depth the confirmatory analysis we conducted – as it is boring and distracts from our paper's main message.

Total Assets	43798	159	118130	35123	68	52,196	41199	227	102857
Dividends	954	159	4039	96.82	68	254	697	227	3403
Intangible Assets	2429	159	7196	709	68	1,377	1913	227	6114
Employees	8.49	159	14.01	26.12	68	48.98	13.71	227	30.28
Revenue	28858	159	70576	24248	68	38,384	27477	227	62638
Retained Earnings	13826	159	59376	4309	68	6,659	10975	227	49969
Total Income Taxes	1103.94	159	4903.67	217.107	68	374.36	838.285	227	4125.321
Income Taxes Paid	1222	159	5772	111	68	464	889	227	4860
Long-Term Debt	5414	159	16572	7379	68	17,966	6003	227	16986
Capital Expenditures	3493	159	15322	2194	68	3,971	3104	227	13006
Common Shares outstand	4108.08	159	8390.76	667.759	68	1469.90	3077.503	227	7235.754

Source: based on data from Compustat for companies working in sectors that should receive preferential tax treatment in Qianhai.

To what extent do our main variables of interest differ between Hong Kong and Shenzhen? Figure D3 shows the results of many common tests of differences in current assets, profit, retained earnings (as a measure of "cash") and R&D expense in our sample between Hong Kong and Shenzhen. While we have showed very small differences between Hong Kong and Shenzhen in the figure above, the figure below encourages us to exercise a bit of caution when making cross-border comparisons. We used different sample sizes, of samples having different variances. Yet, these data help confirm that companies in the "Qianhai region" do not really differ very significantly from each other. **Thus, our model rightly treats the two jurisdictions as one region for the purposes of thinking about policy change.**

Figure D3: Testing for Differences in Our Model's Main Variables Between Hong Kong and Shenzhen-Based Innovation-Focused Companies

		Equality of means' p-values				Equality of variances' p-values		
	difference in N sizes (HK-SZ)	two sided t-test	Mann-Whitney	Wald-Wolfowitz	Kolgo-morov-Smirov**	equality of variances	Levene	Brn-Fors
Total Current Assets	93	0.14	0.15	0.01	Yes	0.56	0.89	0.59
EBITDA	73	0.68	0.71	0.18	No	**0.05***	0.22	0.18
Retained Earnings	82	0.44	0.39	**0.00***	Yes	**0.00***	**0.02***	**0.01***
R&D Expense	91	**0.00***	**0.00***	0.19	Yes	0.49	0.77	0.48

* significant at the 5% level of significance

** "yes" indicates significantly different from zero (namely Hong Kong means differ from Shenzhen's).

The p-value for the Hotelling T-squared vale (to check for statistically significant differences in any of our variables, namely our model as a whole) came to around 0.0002. As such, there is more than a 99.99% probability that Hong Kong and Shenzhen's innovative companies financials differ (as shown). We conducted the tests for similarities in means on the log values of the variables shown in the figure. We do not explain the variable tests (as the reader can

Google the procedure names we provide). We do want to mention though that the test quality depends on the equality (or closeness of) of sample sizes and the variances of data between the two cities. As our sample data had neither balanced sample sizes or variances, readers may want to pay special attention to the non-parametric test results. As our Method of Moments regression does not rely on parametric assumptions, these differences do not pose a particular problem for our study.

The correlations between variables justify the advanced econometric methods we used. Figure D4 shows significant correlations between many of the variables in our study. Many of these variables correlate very strongly with others – indicating that our independent variables and dependent variables correlate with each other.[271] Yet, looking at the first column (showing the main variable of interest, namely a measure of profits), all variables correlate with profits –except R&D spending (as well as intangible assets/employee numbers to a lesser extent)! Thus, advanced methods need to weed through these high correlations to find the real correlation between profits and R&D spending. Even common sense intuition tells us that more than 12% of the variance in R&D explains the variance in firm profits.

Figure D4: Correlations Between Qianhai Study Variables
(correlation coefficients of levels of each variable expressed in thousands of Hong Kong dollars)

	EBITDA	R&D Expen-se	Current Assets	Total Assets	Capital Expend	LT Debt	Divid-ends	Employ-ees	Intang-ible Assets	Retained Earnings	Rev-enue	Income Taxes	Common Shares
Current Assets	0.70	0.59	1.00	0.89	0.70	0.64	0.70	0.41	0.54	0.71	0.88	0.72	0.68
Total Assets	0.88	0.32	0.89	1.00	0.91	0.81	0.87	0.26	0.45	0.91	0.80	0.88	0.79
Capital Expend-itures	0.97	0.13	0.70	0.91	1.00	0.71	0.95	0.09	0.29	0.98	0.69	0.95	0.81
LT Debt	0.60	0.16	0.64	0.81	0.71	1.00	0.55	0.17	0.31	0.64	0.47	0.57	0.49
Dividends	0.99	0.13	0.70	0.87	0.95	0.55	1.00	0.02	0.30	0.97	0.71	0.98	0.88
EBITDA	1.00	0.12	0.70	0.88	0.97	0.60	0.99	0.04	0.27	0.98	0.70	0.98	0.86
Employees	0.04	0.53	0.41	0.26	0.09	0.17	0.02	1.00	0.21	0.06	0.36	0.02	0.02
Intangible Assets	0.27	0.45	0.54	0.45	0.29	0.31	0.30	0.21	1.00	0.27	0.71	0.24	0.33
Retained Earnings	0.98	0.13	0.71	0.91	0.98	0.64	0.97	0.06	0.27	1.00	0.69	0.97	0.84
Revenue	0.70	0.56	0.88	0.80	0.69	0.47	0.71	0.36	0.71	0.69	1.00	0.69	0.68
Income Taxes	0.98	0.12	0.72	0.88	0.95	0.57	0.98	0.02	0.24	0.97	0.69	1.00	0.87
R&D	0.12	1.00	0.59	0.32	0.13	0.16	0.13	0.53	0.45	0.13	0.56	0.12	0.16
Common Shares	0.86	0.16	0.68	0.79	0.81	0.49	0.88	0.02	0.33	0.84	0.68	0.87	1.00

Our sample of Qianhai-oriented companies consists of over 200 companies. Figure D5 shows the companies we included in our analysis. As previously noted, we searched the universe of Compustat companies – restricting our search to Global Industry Codes (GIC) corresponding to technology, logistics and financial sector companies. The diversification of many companies explains why companies like oil and power companies found their way into our analysis. Nevertheless, we have no guarantee that these companies comprise a census of companies in the Qianhai-focused sectors.[272] Some companies provide data for up to 5 years (from 2009 to

[271] Professional economists will know these problems as multi-collinearity and endogeneity rooted biases.
[272] With a census, we would have the entire population of interest, and thus not need to worry about sample accuracy or the need to take randomised samples.

2014) – with most companies providing less. When looking at differences, we used companies with at least 3 years (providing at least 2 differences).

Figure D5: Companies Analysed in Our Study

Company Name	Periods*	Company Name	Periods	Company Name	Periods
Hong Kong Companies**					
Ahsay Backup Software Dev	2	East Asia Holdings Inv Ltd	1	Shougang Concord Century Hld	5
Akm Industrial Co Ltd	5	Forebase International Hldgs	5	Shougang Concord Intl Ents	3
Austar Lifesciences Ltd	4	Fosun International Ltd	5	Sino-I Technology Ltd	5
Beijing Enterprises Holdings	5	Gold Peak Indus (Holdgs) Ltd	6	Sinomedia Holding Ltd	2
Beijing Tong Ren Tang Chine	3	Goldpac Group Ltd	5	Sinotruk (Hong Kong) Ltd	5
Byd Electronic Intl Co Ltd	5	Greens Holdings Ltd	5	Techtronic Industries Co Ltd	5
Chemoil Energy Ltd	3	Hna International Investment	5	Tianjin Development Hldgs	2
China Aerospace Intl Hldgs	5	Hong Kong & China Gas Co Ltd	3	Timeless Software Ltd	2
China Everbright Intl Ltd	5	Hong Kong Tele Network Ltd	2	Tinci Holdings Ltd	4
China Nonferrous Mining	2	Hua Hong Semiconductor	4	Wai Chi Holdings Co Ltd	4
China Traditional Chn Med Co	5	Lenovo Group Ltd	6	Wanli Intl Hldgs Ltd	3
Cnooc Ltd	5	Mmg Ltd	2	Xiwang Special Steel Co Ltd	2
Cpmc Hldgs Ltd	2	Raymond Industrial Ltd	5	Yan Tat Group Holdings Ltd	4
Cspc Pharmaceutical Group	5	S&C Engine Group Ltd	2	Yashili Intl Hldg	1
Shenzhen Companies**					
Avic International Holdings	2	Launch Tech Co Ltd	5	Shenzhen Mason Tech Co Ltd	1
Byd Co Ltd	5	Powerleader Science & Techny	5	Shenzhen Neptunus Interlong	5
Cgn Power Co Ltd	4	Shenzhen Changfang Light	1	Shenzhen Silver Basis Tech	3
China Intl Marine Containers	3	Shenzhen Click Tech Co Ltd	3	Shenzhen Soling Ind Co Ltd	2
Dongjiang Environmental Co	5	Shenzhen Comix Group Co Ltd	1	Shenzhen Sunshine Laser & El	1
Dynagreen Environmental	4	Shenzhen H&T Int Cont Co Ltd	1	Shenzhen Yitoa Intel Control	1
Evoc Intelligent Tech Co Ltd	5	Shenzhen Hifuture Electric	1	Tianma Microelectronics Co	1
Great Wall Technology Co Ltd	4			Zte Corp	5
Hong Kong Total	**159**			**Shenzhen Total**	**68**

* Periods refers to the number of years.
** These companies categorized according to place of registration. Many of the Hong Kong companies of course are Mainland companies.

In constructing our empirical design, we made two critical assumptions. First, we used EBITDA as a proxy for company profits. EBITDA does not include factors outside the company's core business of using R&D to produce money. Second, we adopted a flexible approach to "cash" – namely money the company can eventually use to invest in R&D (or other ways of increasing profits). As such, we often put "cash" in quotes – and describe the specific variables we used (as seemed most appropriate in the context).[273]

[273] The context, in this case, refers to the fact that some variables correlate so closely with each other – and that differencing, taking natural logs and so forth eats up degrees of freedom. As such, the mathematics of regression did not always work with all variables.

The variables included any regression depend on one's view of what drives company profitability and innovation. Readers will note in another appendix that we performed numerous regressions – usually with similar combinations of variables – when looking for particular effects. We thus looked at our models' main effects against the background (or context) of different views of company profitability – as shown in Figure D6. The classical view for example sees company innovation and profitability stemming from the core factors of production – labour and capital. Thus, any analysis of our variables of interest should control for capital spending and employee numbers. The resource view of companies, on the other hand, might argue that cash, R&D spending and profits come from – not mainly capital and labour – but from the value of resources obtained from long-term debt, common stock, retained earnings and other factors. These variables give companies more money to invest (in R&D and other factors of production). The cash-based view looks particularly at current assets (as a proxy for cash and cash-like instruments) – seeing how cash turns into innovation (and visa versa). The full model basically consists of trolling for relationships – adding lots of variables and seeing what is significant. **Each theoretical view of profitability thus would control for different factors and find different reasons for empirical outcomes.**

Figure D6: Regression Models Tested in Each Study

Ideal-type Model	Description
Main Effects Model	
R&D on profitability	We look at the way that R&D spending affects EBITDA (the least noisy measure of profits) – while controlling for other factors.
R&D effects on Revenue	Maybe R&D does not affect profits (because of reinvestment). So by looking at revenue growth, we can assess whether companies grow – a less noisy more of innovation's effect.
Profitability on "Cash"	Profits should attract cash (both internally generated funds as well as outside investment). Basically, this model represents the feed-back loop from profits (the goal) and cash (the instrument).
"Cash" on R&D	Cash only serves an innovative growing company only to the extent such cash can provide resources for growth (namely through more R&D).
Theoretical Worldview	
Classical view	Focuses on explaining Qianhai companies' profits arising from the classical factors of production, labour (number of employees) and capital (capital spending).
Resource view	Looks at the extent to which profits come from resources pulled in by long-term debt, common shares, and total assets available for company activities.
Cash-based view	Accepting the view that cash-is-king, this approach focuses on cash directly and any proxies which illustrate cash flows (like tax payments).
Full Model	The least credible of any model, this approach tries to apply various approaches at the same time.
Grouping	
City groups (fixed effects)	This looks at whether a dummy variable representing whether the company hails from Hong Kong or Shenzhen has a significant effect on the regression relationship in question. Significant effects make parameters for each city potentially different (which we find in many cases).
Pooled (random effects)	We model Qianhai by treating all companies as if they came from a single, united market. In this approach, we avoid looking at company's city (as such a focus might introduce biases).

Background on modelling analysis

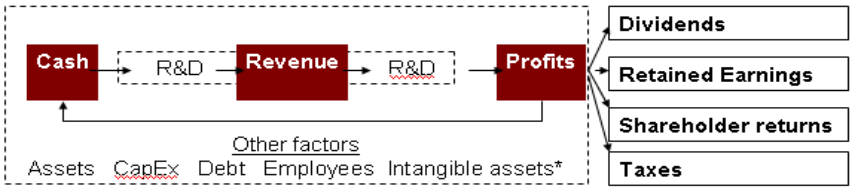
Our model consists of a system of three endogenously determined relationships between cash, R&D spending and profit.[274] Figure D7 shows the variables and parameters used in the model. The equation at the bottom of the figure repeats the system of equations we used (and which we have described in several other places in this paper). We clearly ignore the substitutability between other factors (*O)* and R&D (*X)* – to keep the model simple. We also present the graphical form of our model, so readers can refer to it as needed.

Figure D7: Major Variables and Parameters Used in our Model

variables	Description
Profits Π	The measure of profitability of innovation – which we proxy by earnings before interest, taxes, depreciation and amortisation (EBITDA). EBITDA shows the effect of innovation-based policies and company choices more clearly than net earnings (which contains the effects of all kinds of financial engineering and other non-operational decisions).
R&D X	Research and development spending, as reported by Compustat. We take whatever they define as R&D – and hope for the best.
"Cash" K	The money that companies use for innovation and the money that comes from such innovation. We use current assets (basically accounting language for cash) from balance sheets – and describe in our analysis how we deal with whether cash results from – or contributes to – innovation.
Other factors O_i	These *i* other factors (like capital spending, employee numbers, etc.) semi-exogenously influence the way cash, R&D and profits cycle through our model. We often use capex as our empirical proxy for these other factors – and provide the mathematical/statistical relationship between these other factors O and specific factors like capex for readers interested in these relationships.

parameters			
alpha α	linear effect of profit, other factors and R&D on cash	**c**	geometric effect of R&D on cash
gamma γ	linear effect of other factors and R&D profits	**d**	geometric effect of cash on R&D spending
beta β	linear effect of profits and cash on R&D spending	**e**	geometric effect of profits on cash
a	geometric effect of profits on attracting/keeping cash	**f**	geometric effect of other factors on profits
b	geometric effect of other variables on cash	**g**	effect of R&D on profits

$$\begin{bmatrix} K \\ X \\ \Pi \end{bmatrix} = \begin{bmatrix} \alpha \Pi^{a} O^{b} X^{c} \\ \beta K^{d} \Pi^{e} \\ \gamma O^{f} X^{g} \end{bmatrix}$$



We defend several of our assumptions and techniques as follows. First, our model does not include other spending on R&D (which as semi-substitutable inputs, we justify this omission as both outside our model's interest and unlikely to be important in practice). Second, we do not

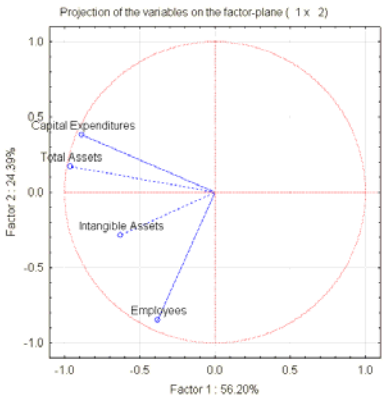
[274] We refer to "cash" in this section without the maddening quotation marks we often use to highlight to the reader that the word describes all cash – not simply cash logged into a company's cash account on its balance sheet.

include cash in the profit structural equation. We follow our economists' instincts, in noting that cash does not belong to the real economy *per se*. Cash clearly has an effect through R&D, thus our model does not omit the important role of cash by any means. Third, we stick to our extremely fuzzy definition of "cash" as investment, cash available from activities, etc.

We chose our seemingly ill-defensible choice for dealing with a "cash" variable for two reasons. First, in this particular context, the available of cash for investment represents an important concern to policymakers with a strong interest in Hong Kong and Shenzhen's status as a financial centre. Thus, our audience has an interest in company activity that results in any action which yields bankable money. Second, we keep an eye on other variables that provide us with intuitions about the extent to which "cash" appears as the result of investment (by banks as loans, shareholders as equity capital, etc.). We informally report how debt, total assets, dividends, retained earnings, and taxes behave in order to look at how "cash" appears and gets distributed. We hope readers find our approach, if less rigorous, more useful for making explanations. Third, **we naturally accept the drawbacks of trying to stuff investment and liquidity into a portmanteau variable with the way we have.**

Our handling of "other expenses" may also make some readers uncomfortable. Figure D8 shows the relationship between the exogenous variables we look at in this study and their relationship to a composite variable we use in our model labelled as *O*. The figure provides a statistically constructed variable which has an exact mathematical and statistical relationship to the exogenous variables of interest. Thus, to work out the predicted effect of *O* in our model on any other variable (like cash or profits), simply use the relationships shown in the figure. For example, readers interested in knowing what our model predicts for capital expenditure (capex) simply need to see how capex relates to *O*. If we attempted to include all these exogenous variables in our model directly, the model would become too complex. Anyway, our model aims at providing insights and intuitions – not working out predicted values of capex.

Figure D8: Single Variable Representation of Other Variables

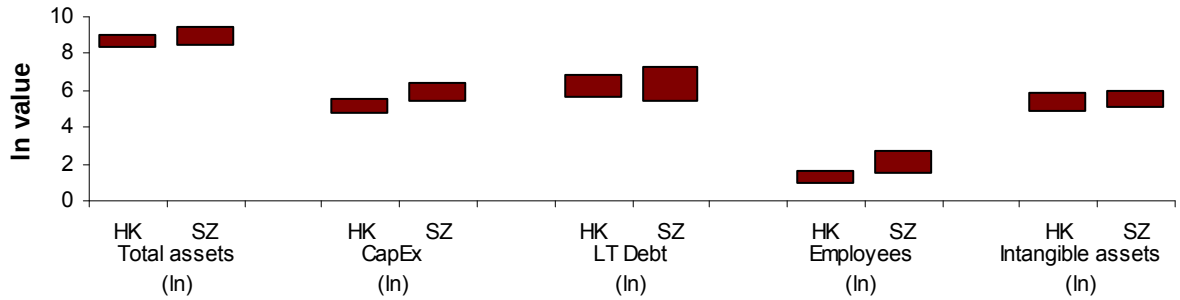


	Total Assets	Capital Expenditures	Employees	Intangible Assets
Group membership	1	1	2	2
Coordinates 1	-.96	-.88	-.38	-.62
Coordinates 2	0.17	0.38	-.84	-.28
Contribution to 1	41%	35%	6%	17%
Contribution to 2	3%	15%	74%	8%
Corr. w/ factor 1	-96%	-88%	-38%	-62%
Corr. w/ factor 2	17%	38%	-84%	-29%
Sine^2 communalities	92%	78%	15%	40%
Factor 1				
Sine ^2 Factor 2	95%	92%	86%	48%

The following shows the principal components decomposition of each of the four "other variables" into a set of two principal components (which can be subtracted from each other in order to provide a value for *O* at every value of the 4 original variables. The coordinates show the weights given to data from each variable. If *C(i)* represents one of the two component *(i={1,2})* and *w(i)* represents the weights for each of the *i* components applied to data from *X(j)* where *j* represents the variable identifying number, then $O = C(1)-C(2) = w(1)X(1)+w(2)X(2)+w(3)X(3)+w(4)X(4)$.

What do these specific values tell us about our model? Figure D9 shows the 95% confidence interval for several of the exogenous variables in our model. The figure shows the results of three statistical tests which assess the statistical significance of differences between these two cities' variables. As shown, a 0% probability exists that the employment and intangible assets levels of Hong Kong's innovative companies match those of Shenzhen. Given the broad similarity between these companies, we can treat Qianhai in an integrated model.

Figure D9: Most Exogenous Variable in Our Model Similar Across Hong Kong and Shenzhen



	P-values for tests of the log values of...				
	Total Assets	Capital Expenditures	Long-Term Debt	Employees	Intangible Assets
2 sided t-test	0.31	0.03	0.81	**0.01***	0.63
Levene	0.97	0.63	0.53	**0.00***	**0.00***
Brown-Fortythe	0.48	0.46	0.51	**0.00***	**0.00***

The figure shows the 95% confidence intervals for the 5 variables shown. We also show the probabilities (p-values) for the two-sided t-test (which shows whether the variables shown for Hong Kong likely equal those of Shenzhen.
Source: authors (based on data from Compustat, 2016).

Likely values of parameters used in our models

Regression analysis allows us to parameterise our model in order to make guesses about the way our variables respond to changes, as well as how their equilibrium and optimal values respond to these changes. We show in another appendix the raw data we obtained from econometric analysis – which served as the basis for this section. Figure D10 shows the mean values for the variables shown in our study – and the parameters estimated during econometric analysis. We have also written the major systems of equations – with parameter estimates put into these equations. In that way, readers can run the numbers themselves in case of interest.

Figure D10: Likely Effects on each of the parameter variables

variable	mean	stdev	variable	mean	stdev
Ln(K)	8.03	1.92	**Ln(Π)**	6.17	2.11
Ln(O)	5.39	2.50	**Ln(X)**	3.96	2.23

parameter	out of equilibrium
a	0.5
b	0.25
c	0.2
d	0.25
e	0
f	0.6
g	0.2

$$\begin{bmatrix} \ln K \\ \ln X \\ \ln \Pi \end{bmatrix} = \begin{bmatrix} 1 + 0.5 \ln \Pi + .25 \ln O + .2 \ln X \\ 1 + .025 \ln K \\ 1 + 0.6 \ln O + 0.2 \ln X \end{bmatrix} \begin{bmatrix} \ln K^e = 2.57 + 1.3 \ln O \\ \ln X^e = 2 + 0.33 \ln O \\ \ln \Pi^e = 1.1 + 0.47 \ln O \end{bmatrix}$$

$$Diff = \begin{bmatrix} \ln K^e - \ln K \\ \ln X^e - \ln X \\ \ln \Pi^e - \ln \Pi \end{bmatrix} = \begin{bmatrix} 1.57 + 1.05 \ln O \\ 1 + 0.33 \ln O \\ 0.1 - 0.13 \ln O \end{bmatrix} - \begin{bmatrix} 0.5 \ln \Pi + .2 \ln X \\ 0.25 \ln K \\ 0.2 \ln X \end{bmatrix}$$

$$\ln \Pi^* = 10(L(1-0.113) + L(2\lambda_1) + LK^{-0.8} - LO^{0.6})) - LX^{-0.8})$$

Using these baseline estimates, we could simulate the effects of policy changes by simply varying the model's parameters. Figure D11 shows the parameters we used for three "levels" of policy changes – which we label as small, medium and large. Each of these levels corresponds with a set or package of policy changes which we described in the previous appendix. The figure also illustrates our model again – for readers who want to see how these parameters will fit into the model.

Figure D11: Parameter Values Used for Out-of-Equilibrium Estimates of Profit Change Due to Qianhai Authority Reform Policies

parameter	letter	base	small	medium	large
Index value		0	1	2	3
geometric effect of cash wrt profits	a	0.5	0.6	0.75	1.2
geometric effect of cash wrt other spending	b	0.25	0.3	0.5	1
geometric effect of cash wrt R&D spending	c	0.2	0.3	0.4	0.9
geometric effect of R&D spending wrt cash	d	0.25	0.3	0.5	0.8
geometric effect of R&D spending wrt profits	e	0	0.2	0.3	0.7
geometric effect of profits wrt other spending	f	0.6	0.7	0.8	0.9
geometric effect of profits wrt R&D spending	g	0.2	0.3	0.4	0.8
linear parameter alpha		3	3	3	3
linear parameters beta		2	2	2	2
linear parameter gamma		2	2	2	2

$$\begin{bmatrix} K \\ X \\ \underbrace{\Pi}_{W} \end{bmatrix} = \begin{bmatrix} \alpha \Pi^a O^b X^c \\ \beta K^d \Pi^e \\ \gamma O^f X^g \end{bmatrix} = \underbrace{\begin{bmatrix} \ln \alpha + a \ln \Pi + \ln bO + c \ln X \\ \ln \beta + d \ln K + e \ln \Pi \\ \ln \gamma + f \ln O + g \ln X \end{bmatrix}}_{Q}$$

The simple assumptions above allow us to estimate the out-of-equilibrium effects of various policies over time. Figure D12 shows the levels for each of the major variables in our model over time and the proportional change (as a way of translating the meaningless variable levels into

actual changes). For example, profits rise by 20% for small policy changes to 70% for large policy changes. Yet, over time, we see that even in the case of small policy changes, profits still grow by about 7% in one time period – up to around 30% for the third time period.

Figure D12: The Effects over Time of Qianhai Authority Policy on Structural Change Leading to Changing Innovation-Related Profitability

	variable levels				proportional change from base case		
variable	**base**	**small**	**medium**	**high**	**small**	**medium**	**high**
Capital (K)	8.25	9.54	11.95	19.44	1.2	1.4	2.4
R&D (X)	4	5.64	7.86	12.74	1.4	2.0	3.2
Profit (Π)	6.04	6.98	7.92	10.06	1.2	1.3	1.7
time period	**t=1**	**t=2**	**t=3**	**t=4**	**t=1**	**t=2**	**t=3**
Capital (K)	9.54	10.5	11.3	12.2	1.10	1.18	1.28
R&D (X)	5.64	6.3	6.6	7.1	1.11	1.18	1.25
Profit (Π)	6.98	7.5	8.4	9.2	1.07	1.20	1.31

Equilibrium and profit maximisation

In order to compare Hong Kong's returns-to-innovation, we first look at the way base line parameter values affect equilibrium profits in Hong Kong's and Shenzhen's Qianhai-sectors-focused companies. Figure D13a shows the value of cash, R&D and profits in equilibrium (namely when feedback effects settle down).[275] The bottom part of the figure shows the parameter values corresponding to the equilibrium solution of our model. The numbers in the lower (gray) part of the table correspond to parameters estimates found in other settings. We referred to several studies where we derived these parameters in a previous appendix. We label each of these scenarios as the Detroit case, fracking case and Silicon Valley case – to provide an intuition about the innovation environment in which we might find these parameters. The Silicon Valley scenario in particular shows the incredible difference that even small parameter changes can have on equilibrium profits. Feedbacks in our model (and probably in real life) make profits for companies operating in the Silicon Valley style innovation environment about 70 times higher than in the Detroit case. Figure D13 shows why these profits increase so quickly. As R&D spending increases, profits accelerate quickly – with very high values of R&D corresponding to far higher levels of profits than only medium-levels of R&D spending.

[275] Such feedback includes in way that a change in R&D spending (for example) would wind its way to changes in cash and profits – which in turn affect R&D spending. Thus if managers in the Qianhai area change in R&D spending by $1, this change would (through these multiplier effects) come to a final $3-4 change in R&D spending.

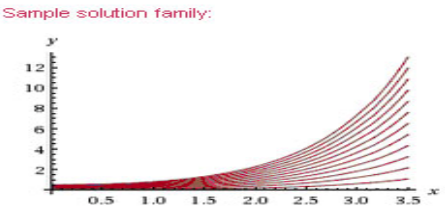
Figure D13a: The Value of Each Variable in Equilibrium for Various Parameters
(with *O* normalized to 1 for *b* and *f* set to 1)

	Base case	Detroit case	Fracking Case	Silicon Valley Case
Equilibrium variable estimates				
Cash (K)	3.96	2.99	7.67	6548.40
R&D (X)	3.54	0.93	3.73	443.49
Profits (Π)	3.50	2.76	3.10	193.69
parameters				
a	.2	.1	.8	.9
c	.1	.1	.1	.5
d	.1	-.7	.1	.4
e	.1	-.3	.1	.3
g	.2	-.2	.1	.7

$$\begin{bmatrix} \ln K^e \\ \ln X^e \\ \ln \Pi^e \end{bmatrix} = \frac{1}{1 - adg - cd - eg} \begin{bmatrix} 1 - eg & ag + c & a + ec \\ d & 1 & ad + e \\ dg & g & 1 - cd \end{bmatrix} \begin{bmatrix} \ln \alpha + b \ln O \\ \ln \beta \\ \ln \gamma + f \ln O \end{bmatrix}$$

The figure shows several parameter estimates for our base model and the resulting equilibrium value of our variables of interest. We label each set of parameters after a case which typifies that set of parameters.

Figure 13b: Illustration of the way that R&D spending feeds back in to profits

Quantitative change	Illustration of change
$\frac{d\Pi^e}{dX} = (\gamma O^f g)\frac{d^2X}{d\Pi^2}X - \frac{dX}{d\Pi} - (\gamma O^f g)X^e$	
$\frac{d\Pi^e}{dX} = \frac{1}{1+\sqrt{37}}\left[c(e^{\frac{1}{6}(\sqrt{37}-1)X}(\sqrt{37}-1)e^{\frac{\sqrt{37}}{3}X} + \sqrt{37}) + e^{(\frac{1-\sqrt{37}}{6})x}\right]$	
$\approx 0.15c(e^{-0.8X}(1 \text{ le}^{2X}) + e^{-0.85X}$	

Each case corresponds with an equilibrium level of spending on other items (like wages or intangible assets). Figure 14 shows the equilibrium level of other spending (signified by the variable *O*). Such other spending increases almost proportionally with profits and other model variables. In some sense, these other expenses drive our model (as they represent the only exogenous variable in our model). Thus, moving from the fracking case to the Silicon Valley case requires an almost 100 fold increase in this other spending. Again, as shown by the equations in the figure, these other expenses increase so quickly because such spending relates directly with the model's parameters.

Figure D16: The Way Profits Change When R&D Depends Only on Exogenous Variables

	Base case	Detroit case	Fracking Case	Silicon Valley Case
Equilibrium variable estimates				
Change in Profits	3.96	2.99	7.67	6548.40
Equilibrium *O*	3.54	0.93	3.73	443.49
parameters				
a	.2	.1	.8	.9
c	.1	.1	.1	.5
d	.1	-.7	.1	.4
e	.1	-.3	.1	.3
g	.2	-.2	.1	.7

$$\frac{d\Pi^e}{dX} = Q + \frac{-(ad+e)g^2 + (1-cd)g)}{(f+b)} \ln^{-1} O \quad \ln O\big|_{\frac{d\Pi}{dX}=0} = \frac{(ad+e)g^2 - (1-cd)g)}{(f+b)Q}$$

$$Q = -(ad+e)g^2 + (1-cd)g)\left(\frac{1}{ag+c}\right)\ln^{-1}\beta + \left(\frac{1}{(a+ec)}\right)\ln^{-1}\gamma + \left(\frac{1}{(1-eg)}\right)\ln^{-1}\alpha$$

Looking at dynamic properties of Qianhai model

The model's variables react surprisingly over time. Figure D17 shows the way that our base model translates into a dynamic model (looking at the effects on profits over time). The base case scenario shows the basic parameters for the model. Cash's reaction to changes in parameters values show how innovation policies radically affect innovative companies in a place like Qianhai. In the average city case, cash stays flat over time. In the Detroit case, cash needs skyrocket. In the Silicon Valley case, cash needs increase – though mostly in line with R&D spending needs. In the average city case and Detroit case, companies need less R&D over time – having failed to reach a critical threshold for innovation.

Figure D17: Comparison of Dynamic Responses for Parameterizations of Our Model

Base Case

$$\begin{bmatrix} \dot{K} \\ \dot{X} \\ \dot{\Pi} \end{bmatrix} = \begin{bmatrix} aK + bX + c\Pi \\ dK + eX + f\Pi \\ gK + hX + j\Pi \end{bmatrix}$$

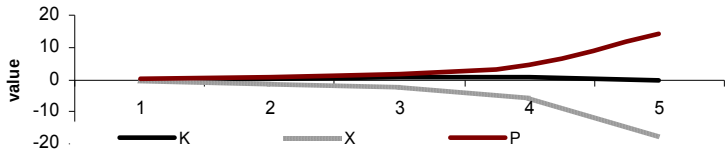
$$\begin{aligned} K &= -.57e^{1.5}t - 0.40e^{-.001t} + 0.7 \\ X &= -.57e^{1.5} - 0.40e^{-.001} + 0.7 \\ \Pi &= -.57e^{1.5} - 0.40e^{-.001} + 0.7 \end{aligned}$$

for all constants =0.5

Classic "Average City" Case

	K	X	Π	Description
K dot	0.2	-0.4	0.9	Cash increases a bit at higher values, decreases as R&D increases and as profits go up.
X dot	0.5	0.5	0.9	R&D spending increases mostly with more resources, increases slightly with size, and alot with more profits
Π dot	0.1	0.2	-0.9	Profits increase a little with cash, a little with R&D and decreases returns.

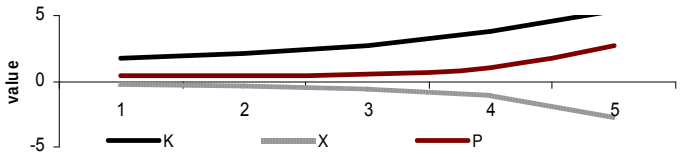
$$K = -0.7.e^{-t} - 0.14e^{0.3t} + 0.65e^{0.13t}$$
$$X = 0.5.e^{-t} - 0.86e^{0.3t} - 0.10e^{0.13t}$$
$$\Pi = -0.7.e^{-t} + 0.7e^{0.3t} + 0.07e^{0.13t}$$



Classic Detroit Case

	K	X	Π	Description
K dot	-0.2	-0.1	0.2	Cash increases a lit at higher values, decreases as R&D increases and as profits go up.
X dot	0.1	-0.1	-0.2	R&D spending increases mostly with more resources, increases slightly with size, and alot with more profits
Π dot	0.1	0.1	0.2	Profits increase a little with cash, a little with R&D and decreases returns

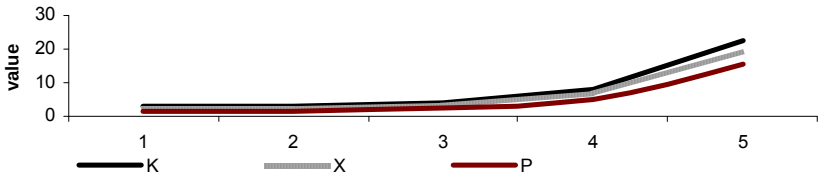
$$K=0.5e^{-0.2t} - 0.4e^{(-0.2+0.1i)t} + 0.8e^{(-0.15-0.1i)t}$$
$$X=(0.5+.5i)e^{-0.2t} + 0.7e^{(-0.2+0.1i)t} - (0.02-0.15i)e^{(-0.15-0.1i)t}$$
$$\Pi=(-0.5-0.5i)e^{-0.2t} - 0.7e^{(-0.2+0.1i)t} - (0.02+0.15i)e^{(-0.15-0.1i)t}$$



Classical Silicon Valley Case

	K	X	Π	Description
K dot	.8	.9	1.2	Cash increases a lit at higher values, decreases as R&D increases and as profits go up.
X dot	.7	.8	.9	R&D spending increases mostly with more resources, increases slightly with size, and alot with more profits
Π dot	.6	.7	.4	Profits increase a little with cash, a little with R&D and decreases returns

$$K = -0.7e^{2.3t} - 0.6e^{-0.3t} - 0.4$$
$$X = -0.6e^{2.3t} - 0.2e^{-0.3t} + 0.7$$
$$\Pi = -0.76e^{2.3t} + 0.6e^{-0.3t}$$



Appendix V: Raw Econometric Results

In this section, we provide the raw results of our econometric analysis.

Evidence for Effect on Profits

Figure E1: Something Associated with R&D Likely Decreases Profits (but Increases Revenues) for Qianhai in General (but not for Hong Kong and Qianhai Separately)
(dependent variable as levels in thousands HKD of EBIDTA and values of independent variables shown)

	Levels of			Annual Differences in		
	Classical Model	Resources Model	Cash Model	Classical Model	Resources Model	Cash Model
Intercept	812731.1	**677430.3***	446.0650	6985.7	**-650690***	**-489487***
	435793.3	305349.0	410.9670	323355.9	282952.7	213026.2
Year	-402.4	**-337.1***		-3.35	**324***	**243***
	216.6	151.8		160.80	140.7	105.9
Capital Expenditures	**1.6***		**0.56***	**0.68***		
	0.0		410.96	0.10		
Employees	**-56.1***		**12.31***	0.35		
	13.2		6.12	26.9		
R&D Expense	0.5*	-0.3	**0.45***	-0.07	**-2***	**-2***
	0.2	0.2	0.12	0.40	0.5	0.3
City No. (1=HK for diff)	-1345.9	**1420.9***	173.68	349.75	242	-284
	731.6	538.0	0.12	409.30	354.1	269.0
GIC Group	**-439.8***		-74.11	-65.61	-122	3
	149.9		63.40	89.70	77.0	59.4
Total Assets		-0.0			-0*	
		0.0			0.0	
Long-Term Debt		-0.0	0.01		-0*	
		0.0	0.01		0.0	
Intangible Assets		0.1	0.17*		0*	
		0.0	0.02		0.1	
Retained Earnings		0.4*	-0.03		0*	
		0.0	0.02		0	
Common Shares Outstanding		0.3*	0.12*		-0	
		0.1	0.03		0.1	
Total Income Taxes			4.20*			0
			0.21			0.2
Total Current Assets			-0.08*			-0*
			0.01			0.0
R2	**95%**	**98%**	**99%**	**53%**	**66%**	**80%**

Dependent variables are EBITDA and changes in EBITDA. The rows underneath each variable refer to the standard deviation of the parameter estimate (where the parameter added and subtracted by two times this standard deviation gives the two numbered 95% confidence interval for the parameter estimate).

Figure E2: The Most Advanced Statistical Method (Method of Moments) Fails to Find Any Effect of Levels of R&D on Profits (EBIDTA)

(dependent variable as "pure" profits)

Effect	Quasi J-Statistic*	Quasi J-Statistic*	Non-linear model
Geometric Effect of the Magnitude of Intangible Assets	11.93		
Interaction Between the Magnitude of Current and Magnitude of Employment	6.03		
		71.4*	
Capital Expenditure		**2674.3***	
Long-term debt		**154.479.7***	
R&D Expense		**7.5***	
Intangible Assets		**3.1***	
Interaction between the Log of Total Current Assets and the Log of Intangible Assets	5.9		
Squared geometric effect of Total Current Assets	4.8		
The log of the employment	5.7		
Intercept	0.4		
Log of Total Current Assets	0.4		
Squared Geometric Effect of the Log of Employment	1.1		
The Log of Intangible Assets	2.6		
"Pure" R&D	0.5		
The Squared Geometric Effect of "Pure" R&D	0.4		
The Interaction Between Employment and the Log of the Value of Intangible Assets	0.4		
Interaction Between the Log of Total Current Assets and "Pure" R&D	1.1		
The Interaction Between the Log of Employment and "Pure" R&D	0.1		
The Interaction Between the Log of Intangible Assets and "Pure" R&D	2.0		
"Pure" R&D			0.36
The Squared Geometric Effect of "Pure" R&D			0.25
"Pure" Cash			0.08
The Squared Geometric Effect of "Pure" Cash			0.16
The Interaction Between "Pure" R&D and "Pure" Cash			0.01

The figure shows the method of moments estimates for "pure" profit. The dependent variable controls for other factors affecting profits – thus giving "pure" profits. Method of moments estimation represents a general type of regression, where we use maximum likelihood methods to find regression parameters adjust for heteroskedasticity, and two stage least squares to control for endogeneity.

* We refer to a quasi-J statistic as classical method of moments estimation is a method of over-parameterisation (and relaxation) which we combine with Wald-like statistics (which give estimated betas scaled by standard deviation) in order to assess the size of any effect.

The rows underneath each variable refer to the standard deviation of the parameter estimate (where the parameter added and subtracted by two times this standard deviation gives the two numbered 95% confidence interval for the parameter estimate).

Figure E3: Size of R&D Helps Hong Kong Company Profitability and Hurts Shenzhen's

(dependent variable as logs of EBIDTA and log values of independent variables shown)

	Classical Model	Resources Model	Cash Constraint Model	Non-linear
Intercept	-201.70	-0.80	-44.60	
	107.98	98.00	103.40	
Year	0.10	-0.00	0.02	
	0.05	0.048	0.051	
Log of Capital Expenditures	**0.60***			0.36*
	0.05			0.06
Log of Employment	0.09		-0.15	
	0.09		0.10	
Log of R&D Expenses	**0.18***	**-0.022***	-0.055	
	0.06	0.06	0.07	
Pure R&D Effect				0.03
				0.06
Dummy Variable for City	**-0.64***	0.09	0.20	-0.52*
	0.19	0.16	0.18	0.15
Dummy Variable for GIC Group	**-0.12***	-0.04		
	0.03	0.03		
Log of Total Assets		**0.50***		
		0.15		
Log of Long-Term Debt		0.04	-0.03	
		0.05	0.05	
Log of Intangible Assets		0.04	0.08	
		0.05	0.05	
Log of Retained Earnings		**0.43***	**0.65***	
		0.11	0.10	
Log of Total Current Assets			**0.44***	
			0.16	
Company Specific Effect		-0.00		
		0.00		
Geometric effect of R&D (squared)				0.02*
				0.00
Squared Effect of Capital Expenditures				0.03*
				0.00
Adjusted R2	**80%**	**87%**	**86%**	**80%**

Shows the log value of EBITDA as the dependent variable. "Pure" effects refer to values of a variable after controlling for cofounding covariates. See the statistical appendix for the variables used in these auxiliary regressions. The rows underneath each variable refer to the standard deviation of the parameter estimate (where the parameter added and subtracted by two times this standard deviation gives the two numbered 95% confidence interval for the parameter estimate).

Figure E4: Nothing Affects the Growth of Profits in the Qianhai Region

(annual differences in EBITDA log values as dependent variable and annual differences in independent log values shown)

Variable	Classical Model	Resource Model	Cash Model	Trash Can Company Effects	Trash Can Company Effects
Intercept	-128.60	-144.37	-135.4	-303.34	-0.016
	240.73	241.10	238.53	237.99	0.29
Year	0.06	0.072	0.06	0.15	
	0.11	0.11	0.11	0.11	
Log of Capital Expenditures	0.06			0.004	0.03
	0.16			0.16	0.16
Log of Differences in Employment	0.14			0.10	0.08
	0.28			0.28	0.29
The Log of Differences in the Log of R&D Expenses	0.33	0.38	0.37	0.00	0.24
	0.28	0.27	0.27	0.28	0.28
City Dummy	-0.08	-0.07	-0.09	-0.16	
	0.30	0.30	0.30	0.29	
GIC Group Dummy	-0.00	-0.00	-0.00	0.01	
	0.06	0.06	0.06	0.06	
Log of Differences in Total Assets		0.00		-0.38	-0.10
		0.19		0.20	0.19
Log of Differences in Long-Term Debt		-0.03		-0.03	-0.02
		0.06		0.06	0.06
Log of Differences in Intangible Assets			0.04		
			0.08		
Log of Differences in Retained Earnings				0.46*	
				0.13	
Log of Differences in Revenue				0.92*	0.61
				0.34	0.34
Company Identity Proxy				-0.00	0.00
Adjusted R2	**0%**	**0%**	**0%**	**0%**	**0%**

The rows underneath each variable refer to the standard deviation of the parameter estimate (where the parameter added and subtracted by two times this standard deviation gives the two numbered 95% confidence interval for the parameter estimate).

Figure E5: Most Advanced Methods Fail to Find any Real Effect of R&D on Profits

	Model 1	Model 2	Non-Linear Model
Insignificant Main Effects			
Intercept	0.47	0.45	0.93
Year	0.47	0.45	
Log of Differences in Total Current Assets		0.28	0.31
Log of Differences in Total Assets		0.34	
Log of Differences in Long-Term Debt	0.87	0.52	
Log of Differences in Intangible Assets	0.57	0.78	0.11
Log of Differences in R&D Expense		1.74	
City Proxy	0.14	0.12	
Log of Differences in Capital Expenditures	0.31		
Log of Differences in Employees	0.37		1.04
"Pure" R&D	0.52		0.35
Insignificant quadratic effects			
The Squared Geometric Effect of Log Differences in Total Current Assets			0.46
The Squared Geometric Effect of Log Differences in Employees			0.41
The Squared Geometric Effect of Log Differences in Intangible Assets			0.60
The Squared Geometric Effect of "Pure" R&D			0.99
Insignificant interaction effects			
Interaction Between the Differences in the Log of Total Current Assets and Log Differences in Employment			1.87
Interaction Between the Differences in the Log of Total Current Assets and the Log Differences in Intangible Assets			0.23
Interaction Between the Differences in the Log of Employees and the Log Differences in Intangible Assets			0.00
Interaction Between the Differences in the Log of Total Current Assets and the Log Differences in "Pure" R&D			3.34
Interaction Between the Differences in the Log of Employees and the Log Differences in "Pure" R&D			0.09
Interaction Between the Differences in the Log of Intangible Assets and the Log Differences in "Pure" R&D			3.64

Log Differences in EBITDA as the dependent variable.

Evidence about Revenue

Figure E6: R&D Levels Have a Stronger Relationship with Revenue than Profitability and Changes in R&D Spending Correlate with Decreases in Profits (But increases in Revenues) in the Qianhai Region in General

	Levels			Differences in revenue		
	Classical Model	Resource Model	Profit Model	Classical Model	Resource Model	Profit Model
Intercept	1772710	4174751*	3672708*	2853404*	3030225*	2852546*
	3065871	1859590	1871386	1275657	1168913	1183701
Year	-875	-2074*	-1822*	-1419*	-1507*	-1418*
	1524	924	930	634	581	588
Capital Expenditures	**3***			**2***		
	0			0		
Employees	**188***			65		
	93			106		
R&D Expense	**17***	**6***	**5***	**13***	**6***	**5***
	2	1	1	2	2	2
City No.	-15494*	6667*	3843	1802	198	328
	5147	3182	3152	1615	1526	1514
GIC Group	-102		-838	67	125	90
	1054		619	354	333	332
Total Assets		1*			0*	
		0			0	
Long-Term Debt		-2*			-0	
		0			0	
Intangible Assets		**4***	**4***		1*	1*
		0	0		0	0
Total Current Assets			1*			0*
			0			0
Retained Earnings			0		0	0*
			0		0	0
Total Income Taxes			7*	3	3	3
			2	2	1	2
R2	71%	89%	90%	48%	57%	56%

The rows underneath each variable refer to the standard deviation of the parameter estimate (where the parameter added and subtracted by two times this standard deviation gives the two numbered 95% confidence interval for the parameter estimate).

Figure E7: R&D Growth and Reinvestment Growth Has Small But Noticeable Affects Revenue Growth in Qianhai Region as a Whole But Not in Each City Separately
(dependent variable as annual difference in logs of revenue and annual differences in log independent variables shown)

	Log values of Revenue				Difference of logs of Revenue			
	Classical Model	Resource Model	Profit Model	Full	Classical Model	Resource Model	Profit Model	Full
Intercept	-35.1	104.29	51.13	43.29	0.05	-56.	0.00	0.00
	80.9	68.21	46.23	44.78	0.07	61.95	0.04	0.04
Year	0.02	-0.05	-0.02	-0.02		0.02		
	0.04	0.03	0.02	0.02		0.03		
Log of Differences in Capital Expenditures	**0.32***		**0.18***	**0.16***		0.07		
	0.04		0.03	0.03		0.04		
Log of Differences in Employees	**0.45***		**0.09***	0.05		0.16*		
	0.06		0.04	0.04		0.07		
Log of Differences in R&D Expense	**0.24***	**0.12***	**0.16***	**0.21***	**0.22***	**0.20***	**0.23***	**0.24***
	0.046	0.03	0.03	0.03	0.06	0.07	0.06	0.06
City Proxy	-0.44*	-41*	-0.44*	-0.48*	0.09	0.09	0.08	0.07
	0.14	15	0.12	0.11	0.07	0.07	0.07	0.07
GIC Group Proxy	-0.03		-0.01	-0.006		-0.01		
	0.02		0.018	0.018		0.01		
Log of Differences in Total Assets		1.26*			0.12*		0.20*	
		0.10			0.05		0.05	
Log of Differences in Long-term debt		-0.06*	-0.01	-0.03			-0.01	
		0.02	0.02	0.02			0.01	
Log of Differences in Intangible Assets			0.03	0.03	-0.02		0.01	0.01
			0.02	0.02	0.02		0.02	0.02
Retained Earnings		**-0.18***	-0.03	-0.03			**-0.12***	**-0.10***
		0.07	0.04	0.04			0.03	0.03
Company No				-0*	-0.00			
				0	0.00			
Log of Differences in Common Shares outstand		-0.19*	-0.05	-0.05	0.02			
		0.05	0.04	0.04	0.02			
Log of Differences in Total Current Assets			**0.67***	**0.70***				0.22*
			0.06	0.06				0.05
R2	**86%**	**91%**	**97%**	**97%**	**13%**	**12%**	**22%**	**21%**

The rows underneath each variable refer to the standard deviation of the parameter estimate (where the parameter added and subtracted by two times this standard deviation gives the two numbered 95% confidence interval for the parameter estimate).

Figure E8: Advanced Methods Show Far More Effects on Revenues than Profits

	Model 1	Model 2	Model 3	Nonlinear 1	Nonlinear 2
Intercept	5.84*	6.04*	0.94	66.53	13.30*
Log of Total Assets	235.56*				
Log of Employees	36.77*	19.33*		5.86*	51.02*
Log of Intangible Assets	0.58	10.69*			
GIC Group	4.45*		2.62		
"Pure" R&D	0.15				
City Proxy	0.05		5.92*		
Year Proxy	5.81*		0.87		
Log of Capital Expenditures	42.23*		3.55	3.63	5.49*
Log of Long-Term Debt	23.96*		24.98*		
Log of Employment					
Log of Intangible Assets				0.00	2.32
Log of R&D Expense	53.19*		40.44*	3.55*	
Log of Common Shares Outstanding	6.97*				0.26
Log of Retained Earnings			31.58*	0.00	0.00
Squared Geometric Effects					
Squared Geometric Effect of the Log of Capital Expenditures				7.25*	4.66*
Squared Geometric Effect of the Log of Employees				0.68	3.58
Squared Geometric Effect of the Log of Intangible Assets				1.42	0.33
Squared Geometric Effect of the Log of Retained Earnings				0.00	5.09*
Squared Geometric Effect of the Log of R&D Expense^2				9.90*	
Squared Geometric Effect of the Log of Common Shares outstand^2					3.34
"Pure" R&D					1.29
Squared Geometric Effect of the Log of "Pure" R&D					6.27*
Interactions					
Interaction Between the Log of Capital Expenditures and the Log of Employees				2.92	2.3
Interaction Between the Log of Capital Expenditures and the Log of Intangible Assets				6.62*	2.22
Interaction Between the Log of Employees and the Log of Intangible Assets				0.26	7.35*
Interaction Between the Log of Capital Expenditures and the Log of Retained Earnings				20.20*	1.58
Interaction Between the Log of Employees and the Log of Retained Earnings				5.33*	19.92*
Interaction Between the Log of Intangible Assets and the Log of Retained Earnings				0.39	0.34
Interaction Between the Log of Capital Expenditures and the Log of R&D Expense				0.12	

Interaction Between the Log of Employees and the Log of R&D Expense	0.44	
Interaction Between the Log of Intangible Assets and the Log of R&D Expense	1.17	
Interaction Between the Log of Retained Earnings and the Log of R&D Expense	8.47*	
Interaction Between the Log of Capital Expenditures and the Log of Common Shares Outstanding		7.25*
Interaction Between the Log of Employees and the Log of Common Shares Outstanding		0.00
Interaction Between the Log of Intangible Assets and the Log of Common Shares Outstanding		2.56
Interaction Between the Log of Retained Earnings and the Log of Common Shares outstand		2.27
Interaction Between the Log of Capital Expenditures and the Log of "Pure" R&D		0.82
Interaction Between the Log of Employees and the Log of "Pure" R&D		0.08
Interaction Between the Log of Intangible Assets and the Log of "Pure" R&D		1.63
Interaction Between the Log of Retained Earnings and the Log of "Pure" R&D		5.53*
Interaction Between the Log of Common Shares Outstanding and the Log of "Pure" R&D		2.53

Dependent variables as the log of revenue. The rows underneath each variable refer to the standard deviation of the parameter estimate (where the parameter added and subtracted by two times this standard deviation gives the two numbered 95% confidence interval for the parameter estimate).

What affects R&D?

Figure E9: Changes in Nothing Seem to Cause Changes in R&D Spending in the Qianhai Region

	DR&D	DR&D	DR&D
Intercept	-9066.07	-5838.54	-112989*
	66928.27	50991.60	53487.28
Differenced Year	4.56	2.96	**56***
	33.27	25.35	26.59
Differenced Capital Expenditure	0.00		
	0.01		
Differenced Employee Numbers	**16.39***		
	5.39		
City Proxy (1=HK)	-38.35	**-130.89***	**-63**
	84.67	64.01	67.52
GIC Group Proxy	5.31	5.92	0
	18.56	14.20	14.91
Differenced Total Assets		0.00	
		0.00	
Differenced Revenue		**0.01***	**0***
		0.00	000
Differenced Retained Earnings		0.01*	-0
		0.01	0.00
Differenced Total Income Tax		-0.10	
		0.07	
Differenced Long-term debt		-0.04*	
		0.01	
Differenced Intangible Assets		0.07*	
		0.01	
Differenced Common Share Outstanding		0.01	
		0.03	
Differenced Total Current Assets			-0
			0.00
Differenced Dividends			-0*
			0.09
R2	34%	47%	40%

The rows underneath each variable refer to the standard deviation of the parameter estimate (where the parameter added and subtracted by two times this standard deviation gives the two numbered 95% confidence interval for the parameter estimate).

Effects of R&D and profitability on "Cash"

Figure E10: Levels Data seem to Show an Effect of R&D and Profits on Cash

	Levels of Current Assets			Differences of Current Assets			"Pure Cash" Instruments	
	Classical Model	Resource Model	Full	Classical Model	Resource Model	fddsd	Model 1	Model 2
Intercept	-688431	1786809*	1908.374*	2468.91	315.24		-65.07	-991.31*
	1529171	716265.2	936.971	2456.12	1147.18		2126.86	437.10
Year	341	-889*						
	760	356.1						
Capital Expenditures	0		-0.72	0.09			-0.39*	-2.18*
	0		0.51	0.21			0.19	0.22
EBITDA	**1***	**-1***	**-2.78***		**-0.51***		-122.61	0.37
	0	0.1	0.44		0.16		310.49	0.22
Employees	228*		229.68*	166.11		-58.905		-109.39
	48		26.56	108.02		93.253		62.03
R&D Expense	**9***	**4***	**6.01***	**6.66***	**5.01***	**6.170***	1.79	
	1	0.4	0.50	1.63	1.02			
City No.	-5164*	1540	-618.16	236.73	-719.32	728.35	1422.03	
	2567	1210.0	1595.35	1642.13	780.11			
GIC Group	1261*	459		-179.62	101.14			
	532	246.9		360.39	170.90			
Total Assets		1*			0.39*			0.25*
		-1*			0.02			0.02
Long-Term Debt		0.0	0.78*		-1.10*			
		0.1	0.06		0.14			
Common Shares Outstanding			0.13		1.00*			
			0.20		0.31			
Dividends			3.39					
			1.92					
Intangible Assets			1.20*		-0.36*	-0.34		-0.22
			0.13		0.14	0.21		0.15
Retained Earnings			-0.06		0.08			
			0.14		0.08			
Total Income Taxes			18.23*		3.72*			4.20*
			1.40		0.80			0.70
"Pure" RD								1.46
R2	**78%**	**95%**	**93%**	**12%**	**81%**	**8%**		**60%**

The rows underneath each variable refer to the standard deviation of the parameter estimate (where the parameter added and subtracted by two times this standard deviation gives the two numbered 95% confidence interval for the parameter estimate).

Figure E11: Cash seems to increase as both R&D and as profits rise

	Log of Current assets		Log of Pure cash	
	Model 1	Model 2	Model 1	Model 2
Intercept	60.6	82.87	25.20	-0.98
	80.3	46.46	66.36	0.52
Year	-0.02	-0.04	-0.01	
	0.03	0.02	0.03	
Log of Capital Expenditures	-0.02		-0.20*	-0.28*
	0.05		0.06	0.06
Log of EBITDA	**0.49***		**0.26***	0.13
	0.06		0.08	0.09
Log of Employees	0.26*		-0.07	
	0.06		0.06	
Log of R&D Expense	**0.21***	0.04	**0.09***	
	0.04	0.02	0.03	
City Dummy	0.09	-0.12		
	0.14	0.07		
GIC Group Dummy	0.05	-0.00		
	0.02	0.01		
Log of Revenue		0.28*		
		0.04		
Log of Total Assets		0.60*		0.34*
		0.06		0.09
Log of Long-Term Debt		0.02		
		0.01		
Log of Intangible Assets		0.00	-0.03	-0.08*
		0.02	0.03	0.03
Log of Common Shares outstand			-0.10	-0.15*
			0.05	0.05
"Pure" R&D				0.04
				0.04
Log of Total Income Taxes				0.04
				0.08
R2	86%	96%	14%	25%

The rows underneath each variable refer to the standard deviation of the parameter estimate (where the parameter added and subtracted by two times this standard deviation gives the two numbered 95% confidence interval for the parameter estimate).

Figure E12: The Most Sophisticated Analysis Available Shows that Profits and R&D affect Cash

	Current Assets	"Pure Cash"	Current Assets	"Pure Cash"
Main Effects				
Intercept	1.70	19.82*	0.38	9.47*
Log of Total Assets	**557.32***	**24.87***		
Log of EBITDA			0.64	1.93
Log of Capital Expenditures	**9.98***	**11.56***		0.13
Log of Employees	**6.19***	**4.13***	**22.25***	1.43
Log of Intangible Assets	0.22	**5.42***	**13.20***	**6.51***
Log of R&D Expense	**25.87***		**20.85***	
Log of Common Shares outstand	15.84*	10.24*		
City Dummy	0.99	1.00		
Log of Common Shares Outstanding			0.028	
Log of Long-Term Debt	5.61*			
"Pure" R&D	**3.51***			**20.66***
Quadratic Effects				
Squared Geometric Effect of the Log of Capital Expenditures				0.085
Squared Geometric Effect of the Log of EBITDA			**6.63***	0.27
Squared Geometric Effect of the Log of Employees			0.25	0.66
Squared Geometric Effect of the Log of Intangible Assets			0.04	0.00
Squared Geometric Effect of the Log of R&D Expense			1.02	
Squared Geometric Effect of the Log of "Pure" R&D				6.19*
Squared Geometric Effect of the Log of Common Shares Outstanding			**3.98***	
Interacting Terms				
Log of EBITDA and Log of Common Shares Outstanding			0.10	
Log of EBITDA and Log of Employees			0.54	0.98
Log of EBITDA and the Log Intangible Assets			**4.95***	2.00
Log of Employees and Log of Intangible Assets			**26.69***	3.79*
Log of EBITDA and Log of R&D Expense			1.02	
Log of Employees and Log of R&D Expense			0.75	
Log of Intangible Assets and Log R&D Expense			0.47	
Log of Employees and Log of Common Shares Outstanding			**3.78***	
Log of Intangible Assets and Log of Common Shares Outstanding			1.28	
Log of R&D Expense and Log of Common Shares Outstanding			**7.38***	
Log of Capital Expenditures and Log of Employees				0.33
Log of Capital Expenditures and Log of EBITDA				0.02
Log of Capital Expenditures and Log of Intangible Assets				0.17
Log of Capital Expenditures and "Pure" R&D				0.59
Log of Intangible Assets and "Pure" R&D				2.39
Log of Employees and "Pure" R&D				**5.88***
Log of EBITDA and "Pure" R&D				**7.99***

The rows underneath each variable refer to the standard deviation of the parameter estimate (where the parameter added and subtracted by two times this standard deviation gives the two numbered 95% confidence interval for the parameter estimate).

Figure E13: Regression of Percentage Changes in "Cash" Show No Discernible Effects for Such Small Input Data

	Current assets	Current assets	Current assets	"Pure Cash"
Intercept	-148.41	18.45	93.51	**-0.09***
	101.59	30.09	54.17	0.02
Year	0.07	-0.00	-0.04	
	0.05	0.01	0.02	
Log of Differences in Capital Expenditures	**0.17***		0.02	0.00
	0.06		0.03	0.02
Log of Differences in EBITDA	-0.00	0.00	-0.02	
	0.03	0.01	0.01	
Log of Differences in Employees	0.11		-0.11	-0.07
	0.12		0.06	0.04
Log of Differences in R&D Expense	0.13	0.05		-0.00
	0.11	0.03		0.04
City Dummy	0.21			
	0.12			
GIC Group Dummy	-0.01			
	0.02			
Log of Differences in Common Shares outstand		0.02		**-0.03***
		0.01		0.01
Log of Differences in Intangible Assets		-0.02		**-0.16***
		0.01		0.01
Log of Differences in Long-Term Debt		-0.01		-0.01
		0.00		0.01
Log of Differences in Total Assets		**0.86***	**0.60***	**0.77***
		0.02	0.04	0.03
"Pure" R&D			-0.04	
			0.06	
R2	**7%**	**93%**	**64%**	**79%**

The rows underneath each variable refer to the standard deviation of the parameter estimate (where the parameter added and subtracted by two times this standard deviation gives the two numbered 95% confidence interval for the parameter estimate).

Figure E14: Most Advanced Methods Show Nothing Affects Cash

(instrumental variables and method of moments estimation)

	Log differences			Logs	
	Model 1	Model 2	Model 3	MME Estimate	Quasi J-Statistic
Main Factors/Effects					
Intercept	-59.87	-63.13	0.00	2.65	0.77
Log of Total Current Assets	-0.03		-0.00	-2.15	2.21
Log of Total Assets		-0.01		2.24	1.33
Log of Capital Expenditures	**0.12***			-0.61	1.34
Log of Retained Earnings				-0.60	0.63
Log of Total Income Taxes				0.15	0.07
Year Dummy	0.00	0.03			
City Dummy	0.00	-0.00			
GIC Group Dummy	-0.00				
Log of Differences in EBITDA	0.02	0.02			
Log of Differences in Revenue	-0.05				
Long-term debt		-0.00			
Log of Differences in Employees		0.03	0.02		
Common Shares Outstanding		-0.02			
Log of Differences in Intangible Assets			0.00		
"Pure" Profit			0.01		
Company Identity Dummy			-0.00		
Quadratic Terms					
Squared Geometric Effect of the Log of Capital Expenditures				-0.05	3.49
Squared Geometric Effect of the Log of Retained Earnings				0.09	2.89
Squared Geometric Effect of the Log of Total Income Taxes				0.01	0.20
Squared Geometric Effect of the Log of Total Current Assets				0.81	**6.08***
Squared Geometric Effect of the Log of Total Assets				0.73	2.41
Interactions					
Log of Total Current Assets and Log of Total Assets				-1.71	**5.41***
Log of Total Current Assets and Log of Capital Expenditures				0.05	0.11
Log of Total Assets and Log of Capital Expenditures				0.05	0.07
Log of Total Current Assets and Log of Retained Earnings				0.40	1.89
Log of Total Assets and Log of Retained Earnings				-0.28	0.75
Log of Capital Expenditures and Log of Retained Earnings				0.04	0.25
Log of Total Current Assets and Log of Total Income Taxes				0.32	2.07
Log of Total Assets and Log of Total Income Taxes				-0.11	0.20
Log of Capital Expenditures and Log of Total Income Taxes				0.01	0.08
Log of Retained Earnings and Log of Total Income Taxes				-0.30	**10.08***

Dependent variable as "pure" R&D with power link function. The rows underneath each variable refer to the standard deviation of the parameter estimate (where the parameter added and subtracted by two times this standard deviation gives the two numbered 95% confidence interval for the parameter estimate).

Evidence for other empirical observations

Figure E15: R&D and Innovation Seem to Have No Effect on Dividend Payouts
(dependent variable as annual difference in logs of dividends and annual differences in log independent variables shown)

	Model 1	Model 2	Model 3
Intercept	-0.02	56.03	57.23
	0.17	259.18	260.18
Log Differences in Total Assets	0.27		
	0.19		
Log Differences in Capital Expenditures	0.00		
	0.16		
Log Differences in Long-Term Debt	**-0.12***		
	0.06		
Log Differences in EBITDA	**0.36***	**0.36***	**0.36***
	0.09	0.09	0.09
Log Differences in Employees	**0.82***		
	0.28		
Log Differences in Total Income Taxes	-0.06		
	0.10		
Log Differences in R&D Expense	-0.11	-0.10	-0.10
	0.28	0.29	0.29
City Dummy	0.05	0.07	0.08
	0.31	0.32	0.32
Year Dummy		-0.02	-0.02
		0.12	0.12
Log Differences in Retained Earnings		0.05	0.05
		0.14	0.14
Log Differences in Total Current Assets		0.34	0.34
		0.23	0.24
Log Differences in Intangible Assets		-0.06	-0.06
		0.10	0.10
GIC Group Dummy		0.02	0.02
		0.06	0.06
Company No			-0.00
			0.00
R2	**15%**	**8%**	**7%**

Dependent variable as log difference of dividends. The rows underneath each variable refer to the standard deviation of the parameter estimate (where the parameter added and subtracted by two times this standard deviation gives the two numbered 95% confidence interval for the parameter estimate).

Figure E16: R&D Money More Likely to Choose Shenzhen than Hong Kong (and Getting Worse Over Time)

Probability of Hong Kong rather than Shenzhen (R&D remains negatively significant).

	Model 1	Model 2	Model 3
Intercept	0.17	**121.82***	-0.02
	0.42	50.29	0.21
Log of Total Assets	0.15		
	0.10		
Log of Capital Expenditures	**-0.09***		
	0.04		
Log of Long-Term Debt	-0.03		
	0.02		
Log of EBITDA	0.09	0.01	
	0.06	0.04	
Log of Employees	0.00		
	0.05		
Log of Retained Earnings	-0.02	0.02	
	0.06	0.04	
Log of R&D Expense	**-0.11***	**-0.09***	**-0.11***
	0.03	0.02	0.023
Log of Total Current Assets		0.05	**-0.11***
		0.06	0.04
Log of Revenue			**0.10***
			0.04
Log of Total Income Taxes			0.00
			0.02
Log of Common Shares Outstanding			**0.17***
			0.02
Log of Intangible Assets		0.00	
		0.02	
GIC Group Dummy		0.00	0.00
		0.01	0.01
Company ID Dummy		0.00	
		0.00	
Year Dummy		**-0.06***	
		0.02	
R2	**12%**	**8%**	**41%**

Dependent variable as the probability of choosing Hong Kong (rather than Shenzhen) The rows underneath each variable refer to the standard deviation of the parameter estimate (where the parameter added and subtracted by two times this standard deviation gives the two numbered 95% confidence interval for the parameter estimate).

E17: Propensity Score Matching for Joint Hong Kong-Shenzhen Comparisons

Company Name	City	Score	Company Name (cont)	City	Score
Beijing Enterprises	Hong Kong	1.21	**Gold Peak Indus (Hol**	Hong Kong	0.077
Cgn Power Co Ltd	Shenzhen	1.16	**Wai Chi Holdings Co**	Hong Kong	0.068
Shougang Concord Cen	Hong Kong	1.076	**Fosun International**	Hong Kong	0.068
Gold Peak Indus (Hol	Hong Kong	0.845	**Cnooc Ltd**	Hong Kong	0.060
Zte Corp	Shenzhen	0.842	**Beijing Enterprises**	Hong Kong	0.059
China Aerospace Intl	Hong Kong	0.837	**Shougang Concord Cen**	Hong Kong	0.057
Hna Investment	Hong Kong	0.825	**Shenzhen Neptunus In**	Shenzhen	0.056
Zte Corp	Shenzhen	0.763	**Shenzhen Neptunus In**	Shenzhen	0.056
Lenovo Group Ltd	Hong Kong	0.712	**Akm Industrial Co Lt**	Hong Kong	0.055
Fosun International	Hong Kong	0.688	**Sinotruk (Hong Kong)**	Hong Kong	0.052
Wai Chi Holdings Co	Hong Kong	0.671	**Akm Industrial Co Lt**	Hong Kong	0.050
Shenzhen Neptunus In	Shenzhen	0.657	**Wai Chi Holdings Co**	Hong Kong	0.044
China Traditional Ch	Hong Kong	0.638	**Dongjiang Environmen**	Shenzhen	0.036
China Traditional Ch	Hong Kong	0.634	**Raymond Industrial L**	Hong Kong	0.034
Hua Hong Semiconduct	Hong Kong	0.616	**Great Wall Technolog**	Shenzhen	0.028
Powerleader Science	Shenzhen	0.610	**Goldpac Group Ltd**	Hong Kong	0.028
Lenovo Group Ltd	Hong Kong	0.583	**Akm Industrial Co Lt**	Hong Kong	0.014
Dongjiang Environmen	Shenzhen	0.561	**Beijing Enterprises**	Hong Kong	0.011
Austar Lifesciences	Hong Kong	0.558	**Byd Co Ltd**	Shenzhen	-0.000
Powerleader Science	Shenzhen	0.471	**Shougang Concord Cen**	Hong Kong	-0.008
Byd Electronic Intl	Hong Kong	0.456	**Forebase Internation**	Hong Kong	-0.011
Evoc Intelligent Tec	Shenzhen	0.448	**Sinotruk (Hong Kong)**	Hong Kong	-0.019
Great Wall Technolog	Shenzhen	0.438	**Tinci Holdings Ltd**	Hong Kong	-0.019
Cspc Pharmaceutical	Hong Kong	0.433	**Hna Investment**	Hong Kong	-0.020
Byd Electronic Intl	Hong Kong	0.426	**Cgn Power Co Ltd**	Shenzhen	-0.028
Cnooc Ltd	Hong Kong	0.385	**Goldpac Group Ltd**	Hong Kong	-0.043
Yan Tat Group Holdin	Hong Kong	0.377	**Evoc Intelligent Tec**	Shenzhen	-0.061
China Everbright Int	Hong Kong	0.365	**Sino-I Technology Lt**	Hong Kong	-0.068
Lenovo Group Ltd	Hong Kong	0.357	**Forebase Internation**	Hong Kong	-0.075
Dynagreen Environmen	Shenzhen	0.340	**Raymond Industrial L**	Hong Kong	-0.076
Gold Peak Indus (Hol	Hong Kong	0.336	**Evoc Intelligent Tec**	Shenzhen	-0.085
China Everbright Int	Hong Kong	0.318	**Byd Electronic Intl**	Hong Kong	-0.085
Austar Lifesciences	Hong Kong	0.301	**Lenovo Group Ltd**	Hong Kong	-0.090
China Traditional Ch	Hong Kong	0.287	**Greens Holdings Ltd**	Hong Kong	-0.092
Beijing Enterprises	Hong Kong	0.279	**Sino-I Technology Lt**	Hong Kong	-0.105
Cgn Power Co Ltd	Shenzhen	0.261	**Evoc Intelligent Tec**	Shenzhen	-0.116
China Aerospace Intl	Hong Kong	0.254	**Gold Peak Indus (Hol**	Hong Kong	-0.138
Techtronic Industrie	Hong Kong	0.245	**Shougang Concord Cen**	Hong Kong	-0.139
Shenzhen Neptunus In	Shenzhen	0.235	**Dynagreen Environmen**	Shenzhen	-0.140

Goldpac Group Ltd	Hong Kong	0.230	**Launch Tech Co Ltd**	Shenzhen	-0.154
Techtronic Industrie	Hong Kong	0.209	**Zte Corp**	Shenzhen	-0.158
Byd Co Ltd	Shenzhen	0.208	**Gold Peak Indus (Hol**	Hong Kong	-0.166
Sinotruk (Hong Kong)	Hong Kong	0.201	**China Aerospace Intl**	Hong Kong	-0.206
Yan Tat Group Holdin	Hong Kong	0.196	**Cspc Pharmaceutical**	Hong Kong	-0.233
China Aerospace Intl	Hong Kong	0.193	**Powerleader Science**	Shenzhen	-0.233
Fosun International	Hong Kong	0.192	**Launch Tech Co Ltd**	Shenzhen	-0.236
Austar Lifesciences	Hong Kong	0.190	**Tinci Holdings Ltd**	Hong Kong	-0.252
Beijing Enterprises	Hong Kong	0.188	**Lenovo Group Ltd**	Hong Kong	-0.277
Dongjiang Environmen	Shenzhen	0.185	**Powerleader Science**	Shenzhen	-0.304
Raymond Industrial L	Hong Kong	0.180	**Great Wall Technolog**	Shenzhen	-0.324
Cnooc Ltd	Hong Kong	0.179	**Sinotruk (Hong Kong)**	Hong Kong	-0.328
China Traditional Ch	Hong Kong	0.159	**Raymond Industrial L**	Hong Kong	-0.358
Sino-I Technology Lt	Hong Kong	0.154	**Greens Holdings Ltd**	Hong Kong	-0.363
Cnooc Ltd	Hong Kong	0.153	**Forebase Internation**	Hong Kong	-0.367
Launch Tech Co Ltd	Shenzhen	0.148	**Sino-I Technology Lt**	Hong Kong	-0.374
China Everbright Int	Hong Kong	0.145	**Hna Investment**	Hong Kong	-0.390
Fosun International	Hong Kong	0.139	**Shougang Concord Cen**	Hong Kong	-0.425
Yan Tat Group Holdin	Hong Kong	0.132	**Forebase Internation**	Hong Kong	-0.474
Techtronic Industrie	Hong Kong	0.120	**Shougang Concord Cen**	Hong Kong	-0.479
Byd Co Ltd	Shenzhen	0.119	**Cspc Pharmaceutical**	Hong Kong	-0.521
Cspc Pharmaceutical	Hong Kong	0.114	**Shougang Concord Cen**	Hong Kong	-0.595
Launch Tech Co Ltd	Shenzhen	0.109	**Hna Investment**	Hong Kong	-0.662
Dongjiang Environmen	Shenzhen	0.104	**Greens Holdings Ltd**	Hong Kong	-0.696
Byd Co Ltd	Shenzhen	0.096	**Byd Electronic Intl**	Hong Kong	-0.743
Tinci Holdings Ltd	Hong Kong	0.086	**Greens Holdings Ltd**	Hong Kong	-0.898
Beijing Enterprises	Hong Kong	0.085	**Zte Corp**	Shenzhen	-0.974
China Everbright Int	Hong Kong	0.082			
Akm Industrial Co Lt	Hong Kong	0.081			
Techtronic Industrie	Hong Kong	0.079			

The figure shows the similarities between Hong Kong and Shenzhen companies which we used for matched analysis. These scores come from taking data from the main variables in our study and constructing a single summary variable based of the level and variance in the original data.

Dynamic values

Our dynamic analyses prove more difficult to report. Dynamic models – unlike linear ones – have parameter estimates which vary wildly from one model to the next. Thus, reporting panels of models in the usual way would not give readers a sense for how the data react under different scenarios. Figure E18 shows one example. The model looks for parameter values that solve the model we presented earlier. For example, growth in R&D spending – when taken by itself – declines by about 3% (or the log value of 0.057. Such a result shows the need to look at all parameters working together in the model.

Figure E18: Slope Estimates for Dynamic Equations Looking at How Profits, Cash, and R&D Spending Changes over Time

Variable	Annual Change in		
	Current Assets	**R&D**	**EBITDA**
Intercept	0.053	0.432	0.559
R&D Expense	-0.0002	0.057	0.046
Total Current Assets	-0.0034	-0.09	-0.141
Capital Expenditures	-0.0271	0.007	-0.149
EBITDA	0.0437	0.048	0.248

The figure shows the change in one unit of the log (ln) value of the independent variables for the change over time in the dependent variables. The dependent variables form the basis for the system of dynamic differential equations shown in the mathematical appendix. We ignore reporting p-values because of the inherent non-linearity in these data (of 4 variables of 111 observations).

Even looking at changes in our variables (a technically better approach to modelling) shows the fragile nature of parameter estimates. Figure E19 shows the changes in our dependent variables (like profits) relative to changes in the independent variables (like changes in R&D). In the figure shown, EBITDA increases by 0.4%. Figure E20 illustrates the same idea – using the magnitude of our variables (namely log values) rather than simple levels or changes. For example, changes in the magnitude (log) value of R&D spending end up relating to a 0.56 proportional change in the proportion of the change in the magnitude of profits. The figures shows only similar relationships.

Figure E19: Relationship between the Annual Change in Our Model's Variables Compared with Each Other and with Other Spending

Variable	Annual Change as the difference in the log value of		
	Total Current Assets	R&D Expense	EBITDA
Intercept	0.065	0.191	-0.034
Annual Change in **EBITDA**	-0.004	0.035	X
Annual Change in **R&D Expense**	0.165	X	0.391
Annual Change in **Total Current Assets**	X	0.261	-0.126
Annual Change in **Capital Expenditures**	0.080	0.109	0.073

Figure E20: Relationship between Qianhai Region Profits and Other Variables Over Time

Variable	Change in the Magnitude of Profits
Intercept	80.60
Year	-0.03
Difference in the Log of R&D Expenses	0.56
Difference in the Log of Total Current Assets	-0.39
Difference in Log of Capital Expenditures	0.09
Log of R&D Expense	0.009
Log of Total Current Assets	-0.06
Log of Capital Expenditures	-0.18
Log of EBITDA	0.24

The figure shows the parameter estimates for the change in the magnitude of profits (namely the log value of the difference between profits from one year to the next). We only report these "consensus" values because they directly affect the parameter values used in our model.

Appendix V: Mathematics in Our Modelling and Statistical Procedures

In this section, we provide an overview of the math we used in the course of this assignment.

Overview of Model's Parameterizations

Before starting on any derivations, we present our model, its use in finding equilibrium and optimum values – and parameters estimate we used in those models. Equation (1) presents the basic model, while equation (2) shows the log values of that model (allowing us to estimate parameter values). Equation (2) also shows the model with the coefficients we estimated from regression analysis. Equation (3) shows the equilibrium values for our model (as basically a mix of structural parameters). Equation (4) boils down the math into a single expression for the equilibrium values of our model which appear as functions of O (or other spending) – basically the only real exogenous variable in our model. By doing the math, we arrive at equation (5). Equation (6) shows the result of our calculations of disequilibrium (as the difference between the equilibrium and current values of our parameters). Equations (7) and (8) show the optimal level of profits after doing dynamic optimisation. We cover details about all these procedures in the following sections.

$$\begin{bmatrix} K \\ X \\ \Pi \end{bmatrix} = \begin{bmatrix} \alpha \Pi^{a} O^{b} X^{c} \\ \beta K^{d} \Pi^{e} \\ \gamma O^{f} X^{g} \end{bmatrix} \tag{1}$$

$$\begin{bmatrix} \ln K \\ \ln X \\ \ln \Pi \end{bmatrix} = \begin{bmatrix} \ln \alpha + a \ln \Pi + b \ln O + c \ln X \\ \ln \beta + d \ln K + e \ln \Pi \\ \ln \gamma + f \ln O + g \ln X \end{bmatrix} = \begin{bmatrix} 1 + 0.5 \ln \Pi + .25 \ln O + .2 \ln X \\ 1 + .025 \ln K \\ 1 + 0.6 \ln O + 0.2 \ln X \end{bmatrix} \tag{2}$$

A B C

$$\begin{bmatrix} \ln K^{e} \\ \ln X^{e} \\ \ln \Pi^{e} \end{bmatrix} = \frac{1}{1 - adg - cd - eg} \begin{bmatrix} 1 - eg & ag + c & a + ec \\ d & 1 & ad + e \\ dg & g & 1 - cd \end{bmatrix} \begin{bmatrix} \ln \alpha + b \ln O \\ \ln \beta \\ \ln \gamma + f \ln O \end{bmatrix} \tag{3}$$

1/A B A*B C

$1 - adg - cd - eg = 1 - 0.25 - 0.05 - 0 = 0.7$ $\begin{bmatrix} 1 & 0.3 & 0.5 \\ 0.25 & 1 & 0.125 \\ 0.05 & 0.2 & 0.05 \end{bmatrix}$ so $\begin{bmatrix} 1.43 & 0.43 & 0.71 \\ 0.36 & 1.43 & 0.18 \\ 0.71 & 0.29 & 0.07 \end{bmatrix} \begin{bmatrix} 1 + 0.6 \ln O \\ 1 \\ 1 + 0.6 \ln O \end{bmatrix}$

$$\begin{bmatrix} \ln K^{e} \\ \ln X^{e} \\ \ln \Pi^{e} \end{bmatrix} = \begin{bmatrix} 1.43 & 0.43 & 0.71 \\ 0.36 & 1.43 & 0.18 \\ 0.71 & 0.29 & 0.07 \end{bmatrix} \begin{bmatrix} 1 + 0.6 \ln O \\ 1 \\ 1 + 0.6 \ln O \end{bmatrix} \tag{4}$$

and

$$\begin{bmatrix} \ln K^{e} \\ \ln X^{e} \\ \ln \Pi^{e} \end{bmatrix} = \begin{bmatrix} 1.43(1 + 0.6 \ln O) & 0.43 & 0.71(1 + 0.6 \ln O) \\ 0.36(1 + 0.6 \ln O) & 1.43 & 0.18(1 + 0.6 \ln O) \\ 0.71(1 + 0.6 \ln O) & 0.29 & 0.07(1 + 0.6 \ln O) \end{bmatrix} = \begin{bmatrix} \ln K^{e} \\ \ln X^{e} \\ \ln \Pi^{e} \end{bmatrix} = \begin{bmatrix} 1.43 + 0.86 \ln O & 0.43 & 0.71 + 0.43 \ln O \\ 0.36 + 0.22 \ln O & 1.43 & (0.18 + 0.11 \ln O) \\ 0.71 + 0.43 \ln O & 0.29 & (0.07 + 0.04 \ln O \end{bmatrix}$$

$$\begin{bmatrix} \ln K^e = 2.57 + 1.3 \ln O \\ \ln X^e = 2 + 0.33 \ln O \\ \ln \Pi^e = 1.1 + 0.47 \ln O \end{bmatrix} \quad (5)$$

$$\text{Disequilibrium} = \begin{bmatrix} \ln K^e - \ln K \\ \ln X^e - \ln X \\ \ln \Pi^e - \ln \Pi \end{bmatrix} = \begin{bmatrix} 1.57 + 1.05 \ln O \\ 1 + 0.33 \ln O \\ 0.1 - 0.13 \ln O \end{bmatrix} - \begin{bmatrix} 0.5 \ln \Pi + .2 \ln X \\ 0.25 \ln K \\ 0.2 \ln X \end{bmatrix} \quad (6)$$

$$\ln \Pi^* = \frac{1}{e} \ln(1 - 1 - \ln(d\beta\alpha c\beta d) + 2\lambda_1 + (1-d)K - \ln(g\gamma\alpha c\beta d) - f \ln O - (g-1)\ln X) \quad (7)$$

$$\ln \Pi^* = 10(L(1-0.113) + L(2\lambda_1) + LK^{-0.8} - LO^{0.6})) - LX^{-0.8}) \quad (8)$$

The Effect of Short-run Changes in Resources and Policies

Changing policies unsurprisingly has a larger impact on profits than simply giving Qianhai's companies more money. Figure F1 shows the simplest way we know how to illustrate this impact. Each column shows the effects of small change in cash, R&D and profits (respectively). The first line shows the equation from our model. The second line traces through the change of each of these factors on the other two factors – using the incremental value symbol (Δ) to the relevant variable. Thus, the value ΔK represents a cash infusion (of the type that the Hong Kong government does when it simply writes cheques). The value $\Delta\Pi$ represents a policy which increases these firms' profits (like a tax write-down). The last line shows the effect that windfall gains in cash, R&D money or profit have on short-term profits – after tracing though the other two equations (thus we use two difference signs $\Delta\Delta$ to show this is the effect after "spins" through two other variables).

Figure F1: The One-Period Effect of Added Resource Endowments to Qianhai Firms' Profits

	resource drop as ΔK	resource drop of ΔX	profit windfall of ΔΠ
Structural equation	$K = \alpha\Pi^a O^b X^c$	$X = \beta K^d \Pi^e$	$\Pi = \gamma O^f X^g$
Change in variables	$\Delta X = \beta\Pi^e(\Delta K^d)$ $\Delta\Pi = \gamma O^f(\Delta X)^g$	$\Delta K = \alpha\Pi^a O^b(\Delta X^c)$ $\Delta\Pi = \gamma O^f \Delta X^g$	$\Delta K = \alpha O^b X^c \Delta\Pi^a$ $\Delta X = \beta\Delta K^d \Delta\Pi^e$ $\Delta\Pi = \gamma O^f \Delta X^g$
Effect on profit	$\Delta\Delta\Pi_{\Delta K} = \gamma\beta^g O^f \Pi^{eg}(\Delta K^{dg})$	$\Delta\Delta\Pi_{\Delta X} = \gamma O^f \Delta X^g$	$\Delta\Delta\Pi = \gamma\beta\alpha^d O^{f+bd} X^{cd} \Delta\Pi^{ad+eg}$

The ΔΔΠ represents the change in one-period change in profits as we change the variable shown at the column head. The change denoted at the foot of ΔΔΠ represents the initial variable changed.

Let us begin our analysis by looking pair-wise at the differences and ratios of these of these final effects. Looking first at the relationship between the way giving Qianhaiese more cash affects profits versus changing profit policy directly (ie through tax or other policy), equation (1) shows the difference in the effect of profits of both these policies – a helicopter drop of cash subtracted from the effect of changing profit policy has. Equation (2) shows the difference in the affects

each of these policies has on profits. Under what condition would a change in cash equal the effect of a change in profit policy? Equation (3) shows the condition under which giving more cash yields the same change in profits as changing profit policy. Equation (4) shows a solution – expressed as the amount of cash a Qianhai Authority would need to give companies in order for their profits to change as much as a similar change in profit policy. Even common sense tells us that this change must be reasonably large (and we will see the exact difference in the statistical appendix).

$$\Delta\Delta\Pi_{\Delta\Pi} - \Delta\Delta\Pi_{\Delta K} = \Delta\Delta\Pi = \gamma\beta\alpha^{d} O^{f+bd} X^{cd} \Delta\Pi^{ad+eg} - \gamma\beta^{g} O^{f} \Pi^{eg} (\Delta K^{dg}) \quad (9)$$

$$\Delta\Delta\Pi = \gamma O^{f} \Pi^{eg} (\beta\alpha^{d} O^{bd} X^{cd} \Delta\Pi^{ad} - \beta^{g} \Delta K^{dg}) \quad (10)$$

$$\beta\alpha^{d} O^{bd} X^{cd} \Delta\Pi^{ad} = \beta^{g} \Delta K^{dg} \quad (11)$$

$$\Delta K = \sqrt[g]{\alpha\beta^{(1-g)/d} O^{b} X^{c} \Delta\Pi^{a}} \quad (12)$$

$$\frac{\Delta\Delta\Pi_{\Delta\Pi}}{\Delta\Delta\Pi_{\Delta K}} = \frac{\beta^{(1-g)/d} \alpha O^{b} X^{c} (\Delta\Pi)^{a}}{(\Delta K)^{g}} \quad (13)$$

Similarly, a change in R&D funding compares

and $\frac{\Delta\Delta\Pi_{\Delta\Pi}}{\Delta\Delta\Pi_{\Delta X}} = \gamma\beta\alpha^{d} O^{bd} \frac{X^{cd}}{(\Delta X)^{g}} \Delta\Pi^{ad+eg}$ such that $\frac{\Delta\Delta\Pi_{\Delta X}}{\Delta\Delta\Pi_{\Delta K}} = \gamma\beta^{g} (\Delta K)^{d} (\Delta\Pi)^{eg}$ (14)

On the other hand, let's back up and look at the effect of a parameter change. Equation (15) shows the effects of a change on cash of increasing profits by endowment and by increasing the structural parameter affecting profitability. Equation (16) compares the two changes (taking the ratio of a parameter change to an endowment change). As shown, the final term clearly exceeds one (as structural parameters in our model do not stray very far from one). Equation (17) shows the similar thing – for a change in other spending *O*. As if to belabour the point, equation (18) shows the value of profits after taking into account the effects of capital and R&D spending. Equation (19) shows how that total effect of an increase in R&D's impact on profits affects profits.

$$\frac{dK}{d\Pi} = \alpha a \Pi^{a-1} O^{b} X^{c} \quad \frac{dK}{da} = \alpha (\ln \Pi) \Pi^{a} O^{b} X^{c} \quad (15)$$

$$\frac{dK/da}{dK/d\Pi} = \frac{\alpha (\ln \Pi) \Pi^{a} O^{b} X^{c}}{\alpha a \Pi^{a-1} O^{b} X^{c}} = \frac{(\ln \Pi)\Pi}{a} \quad (16)$$

$$\frac{dK}{db} / \frac{dK}{dO} = \frac{\alpha \Pi^{a} (\ln O) O^{b} X^{c}}{\alpha \Pi^{a} b O^{b-1} X^{c}} = \frac{(\ln O) O}{b} \quad (17)$$

$$\Pi = \beta^{g} \alpha^{g} \gamma O^{bdg+f} X^{cdg} \Pi^{g(e+ad)}) \quad (18)$$

$$\frac{d\Pi}{dg} = (\beta\alpha\gamma O^{bd} X^{cd} \Pi^{(e+ad)})^{g} O^{f} = O^{f} g (\beta\alpha\gamma O^{bd} X^{cd} \Pi^{(e+ad)})^{g-1} \quad (19)$$

The Qianhai development assistance corollary: *For short-term (out of equilibrium) attempts to increase Qianhai-region innovative-companies' profits, the Qianhai authorities should prioritise profit assistance first, investment promotion second, and R&D assistance last.*

Only Other Spending Affects the Qianhai's Equilibrium Innovation System

Equation (20) shows both the normal model and the natural log values of the variables in each equation. Equation (21) shows the results of using Cramer's method to solve for the log value of each variable by taking the determinant of the matrix and finding the Jacobian for each variable. Equation (22) shows the simplified view of that system of equations. Equations (23a) through (23c) show the solution for the log of each variable using Cramer rule.

$$\begin{bmatrix} K \\ X \\ \Pi \end{bmatrix} = \begin{bmatrix} \alpha \Pi^{a} O^{b} X^{c} \\ \beta K^{d} \Pi^{e} \\ \gamma O^{f} X^{g} \end{bmatrix} \quad \text{--->} \quad \begin{bmatrix} \ln K \\ \ln X \\ \ln \Pi \end{bmatrix} = \begin{bmatrix} \ln \alpha + a \ln \Pi + b \ln O + c \ln X \\ \ln \beta + d \ln K + e \ln \Pi \\ \ln \gamma + f \ln O + g \ln X \end{bmatrix} \tag{20}$$

$$\begin{bmatrix} -\ln \alpha - b \ln O \\ -\ln \beta \\ -f \ln O \end{bmatrix} = \begin{bmatrix} a \ln \Pi + c \ln X - \ln K \\ d \ln K + e \ln \Pi - \ln X \\ \ln \gamma + g \ln X - \ln \Pi \end{bmatrix} \text{ then } \begin{bmatrix} \ln K - a \ln \Pi - c \ln X \\ \ln X - d \ln K - e \ln \Pi \\ \ln \Pi - g \ln X \end{bmatrix} = \begin{bmatrix} \ln \alpha + b \ln O \\ \ln \beta \\ \ln \gamma + f \ln O \end{bmatrix} \tag{21}$$

$$\begin{bmatrix} 1 & -c & -a \\ -d & 1 & -e \\ 0 & -g & 1 \end{bmatrix} \begin{bmatrix} \ln K \\ \ln X \\ \ln \Pi \end{bmatrix} = \begin{bmatrix} \ln \alpha + b \ln O \\ \ln \beta \\ \ln \gamma + f \ln O \end{bmatrix} \equiv \begin{bmatrix} x \\ y \\ z \end{bmatrix} \tag{22}$$

$$\ln K = \frac{(ag+c)y+(a+ec)z+(1-eg)x}{1-adg-cd-eg} = \left(\frac{(ag+c)}{1-adg-cd-eg}\right)\ln\beta + \left(\frac{(a+ec)}{1-adg-cd-eg}\right)\ln\gamma + f\ln O + \left(\frac{(1-eg)}{1-adg-cd-eg}\right)\ln\alpha + b\ln O \tag{23a}$$

$$\ln X = \frac{adz+dx+y+ez}{1-adg-cd-eg1} = \left(\frac{(ad+e)}{1-adg-cd-eg}\right)(\ln\gamma + f\ln O) + \left(\frac{d}{1-adg-cd-eg}\right)(\ln\alpha + b\ln O) + \left(\frac{1}{1-adg-cd-eg}\right)\ln\beta \tag{23b}$$

$$\ln \Pi = \frac{dg}{1-adg-cd-eg}(\ln\alpha + b\ln O) + \frac{g}{1-adg-cd-eg}\ln\beta + \frac{(1-cd)}{1-adg-cd-eg}\ln\gamma + f\ln O \tag{23c}$$

Innovation Policy Proposition. *Qianhai's policies will promote profitability if policy increases Qianhai's α, β and b above those of Hong Kong and Shenzhen separately.* We start our explanation with trivial equation (24) – with QH standing for Qianhai, SZ for Shenzhen and HK for Hong Kong. Qianhai performs better if its profits, R&D spending and cash attracted exceeds those of its component jurisdictions. As profits represent the only final variable we care about (want to maximise), we recall from above that the level of profits simply results from various parameters. Equation (25) shows that profits, according to this model, boil down to a function of companies' other spending *O*. Governments do not get to decide such other spending – though they can incentivize such spending with policy changes. Only structural parameters – the parts of the model the government can affect – influence the way that companies turn other spending *O* into profits. Clearly, if these parameters equal those of Qianhai's constituent jurisdictions, then the Qianhai policy has done nothing to promote profitable innovation. Thus, Qianhai's policies will promote profitability if policy increases Qianhai's α, β and b above those of Hong Kong and Shenzhen separately.

$$\begin{bmatrix} K \\ X \\ \Pi \end{bmatrix}_{QH} = \begin{bmatrix} \alpha \Pi^{a} O^{b} X^{c} \\ \beta K^{d} \Pi^{e} \\ \gamma O^{f} X^{g} \end{bmatrix}_{QH} > \begin{bmatrix} \alpha \Pi^{a} O^{b} X^{c} \\ \beta K^{d} \Pi^{e} \\ \gamma O^{f} X^{g} \end{bmatrix}_{HK} + \begin{bmatrix} \alpha \Pi^{a} O^{b} X^{c} \\ \beta K^{d} \Pi^{e} \\ \gamma O^{f} X^{g} \end{bmatrix}_{SZ} \quad (24)$$

$$\ln \Pi = \frac{dg(\ln \alpha + b \ln O)}{1 - adg - cd - eg} + \frac{g \ln \beta}{1 - adg - cd - eg} + \frac{(1 - cd)(\ln \gamma + f \ln O)}{1 - adg - cd - eg}$$

$$\text{where } W = \left[\frac{g \ln \beta}{1 - adg - cd - eg} + \frac{(1 - cd) \ln \gamma + dg \ln \alpha}{1 - adg - cd - eg} \right] \quad \text{or}$$

$$\ln \Pi = W + \left(\frac{(1 - cd) f + dgb}{1 - (ag - c) d - eg} \right) \ln O \quad (25).$$

Equation (25) above tells us more about the role of policy. Qianhai region governments encourage companies to invest the profit maximising amount of cash into R&D when $ag=c$ and/or when governments set $-eg$ as high as possible. What do we know about the coefficient on *ln O*? We maximise profits when the denominator approaches zero (ie. $\lim(1 - (ag - c)d - eg) \to 0$). Setting the expression equal to zero (in the extreme), we see that $(ag - c)d + eg = 1$, $d = \frac{1 - eg}{(ag - c)}$ and thus $d = \frac{1}{(ag - c)} - \frac{eg}{(ag - c)}$. Such a condition means that we want R&D to respond as much as possible to cash – in other words for *d* to get as large as possible. Such a thing occurs when:

$\lim_{d \to \infty} ag - c = 0$ or $\lim_{d \to \infty} -eg = \infty$

$\lim_{d \to \infty} ag = c$ $\lim_{d \to \infty} -eg = \infty$

or capital responds as much as possible to new R&D (such that the announcement of new R&D would cause investment inflows).

or the feedback between profits and R&D strengthens more than HK and SZ alone.

Thus, the profit maximising condition for encouraging companies to invest cash into R&D occurs.

Qianhai governments will want to maximise the value of *b* and *d* in order to make every dollar of R&D spending count as much as possible. Recalling that if $\Pi = \gamma O^{f} X^{g}$, Qianhai region governments maximise profits when they maximise *g*. Equation (26) shows the way that profits change as the size effect of R&D spending gets larger – with equation (27) providing a slightly simpler view of the expression.

$$\frac{d \ln \Pi}{dg} = \frac{dg(\ln \alpha + b \ln O)(1 - adg - cd - eg)^{-1}}{} = \quad (26)$$

$$\frac{d(\ln\alpha + b\ln O)}{1 - adg - cd - eg} + \frac{dg(ad+e)(\ln\alpha + b\ln O))}{(1 - adg - cd - eg)^2} + \frac{\ln\beta}{(1 - adg - cd - eg)} + \frac{g\ln\beta((ad+e)}{(1 - adg - cd - eg)^2} + \frac{(1 - cd)(ad+e)(\ln\gamma + f\ln O)}{(1 - adg - cd - eg)^2}$$

$$\frac{d \ln \Pi}{dg} = \frac{\ln\beta + d(\ln\alpha + b\ln O)}{(1 - adg - cd - eg)} + \frac{(ad+e)((1 - cd)(\ln\gamma + f\ln O)}{(1 - adg - cd - eg)^2} + g(d(\ln\alpha + b\ln O) + \ln\beta) \quad (27)$$

The terms with denominators will be smaller than the final term without any denominator (for the range of the parameters likely in our model). Thus, profits respond most to changes in R&D policy by $\max[\ln \beta + d(\ln \alpha + b \ln O)]$. The terms ln α and ln β do not interact with companies' other spending O (namely, these parameters do not influence (dlnΠ/dg) as companies increase O).

Changes in the exogenous variable. *A jurisdiction has a larger market size if, in equilibrium and when all other parameters are the same, it has a larger ln(O).* Let us define market size by the size of revenues of innovative firms in a jurisdiction. Assume that – as they operate in reasonably efficient markets – Hong Kong, Shenzhen and Qianhai have similar profit rates. Thus, we could express Hong Kong's profits Π_{HK} as a proportion β of Shenzhen companies' profits and profits represent a proportion $\gamma\Pi$ of top line revenue. Thus $\gamma\Pi_{HK} = \beta\gamma\Pi_{SZ}$, represents the market sizes of each Qianhai jurisdiction, where beta could exceed or undershoot one/unity. As implied by equation (25) above, such market sizes only depend on "other spending" O.

Starting with the equilibrium condition repeated yet again in equation (54), all equilibrium levels depend on $\ln \alpha + b \ln O$, ln β and $\ln \gamma + f \ln O$ (and a matrix of parameter values). Assume $W = 1 - adg - cd - eg$ and assume that Qianhai, Hong Kong and Shenzhen have the same parameter estimates. In this case, Qianhai can have a higher equilibrium value of the variables on the left-hand side of equation (54) if ln O (or spending on "other" expenses like employment or capital) exceeds that of its constituent jurisdictions. By subtracting – by way of an example, profits in Qianhai from Hong Kong (or $\ln \Pi^{e}_{QH} - \ln \Pi^{e}_{HK}$), equation (55) shows such a difference. As shown in equation (56), let us assume that both jurisdictions spend the same money on *ln O*. Let us further assume that Hong Kong must have (for the sake of argument) higher profits *a*. In such a circumstance, we see that either $\ln \gamma_{HK}$ must exceed $\ln \gamma_{QH}$ by the term $a - (f_{HK} - f_{QH}) \ln O$ or f_{HK} must exceed f_{QH} by $(a - \ln \gamma_{HK} + \ln \gamma_{QH}) / \ln O$. In other words, Qianhai must have either higher α and b or γ and f than Hong Kong in order to have higher equilibrium profits. Or – following our assumption that parameter values remain the same in Hong Kong as in Shenzhen and Qianhai, equation (57) shows that Hong Kong (or Qianhai for that matter), in order to have higher profits by *a*, must have other spending O larger by such that $\ln O_{HK} - \ln O_{QH} = a / f$ (the condition shown in equation (58)).

$$\begin{bmatrix} \ln K^{e} \\ \ln X^{e} \\ \ln \Pi^{e} \end{bmatrix} = \frac{1}{W} \begin{bmatrix} 1 - eg & ag + c & a + ec \\ d & 1 & ad + e \\ dg & g & 1 - cd \end{bmatrix} \begin{bmatrix} \ln \alpha + b \ln O \\ \ln \beta \\ \ln \gamma + f \ln O \end{bmatrix} \tag{54}$$

$$\ln \gamma_{HK} + f_{HK} \ln O_{HK} - \ln \gamma_{QH} + f_{QH} \ln O_{QH} \tag{55}$$

$$a = (\ln \gamma_{HK} - \ln \gamma_{QH}) + (f_{HK} - f_{QH}) \ln O \tag{56}$$

$$\ln \gamma_{HK} = \ln \gamma_{QH} + (a - (f_{HK} - f_{QH}) \ln O) \quad \text{or} \quad f_{HK} = f_{QH} + \frac{a - \ln \gamma_{HK} + \ln \gamma_{QH}}{\ln O} \tag{57}.$$

$$(\ln O_{HK} - \ln O_{QH}) = (a / f) \tag{58}$$

As an interesting aside, we can not make any conclusions about the extent to which larger markets correlate with different effects of linear parameters (like α). By way of illustration, consider the ratio of X^e to Π^e, as shown in equation (29), which relies on equilibrium R&D spending described by equation (28). With some rearranging, we see in equation (30) that both of these variables depend only on *O*. Equation (31) represents a differential equation showing the way that this R&D spending-to-profit ratio changes with changes in other spending *O*. Equation (32) shows three parts/pieces of *W* – all of which depend only on geometric parameters, on linear parameters and on ln *O*. Equation (33) shows the change in each of these parts of the previous equation as ln (O) increases. The first two terms become smaller – suggesting that R&D spending as a proportion of profits falls as other spending rises. Yet, the third term contains *ln O* terms in the numerator and denominator. Equation (33) shows the third term separately, defining the previous two terms by the function *u*. Equation (35) focuses in on the value of this third part of the derivative when all the geometric terms (namely all Latin letter parameters) equal 1 -- and thus linearizing the model. The negative sign in front the third term, combined with likely values of α and β larger than 1, make *W* shrink as ln *O* increases. If R&D rose to the same extent that profits rose, we could argue that increasing *O* similarly causes revenues and profits to rise. **But because R&D spending likely shrinks as profits and other spending rises (in the equilibrium case and under these specific assumptions), we can only postulate that R&D and other spending serve as substitutes in equilibrium.**

$$\ln X^e = \frac{d(\ln\alpha + b\ln O) + \ln\beta + (ad+e)(\ln\gamma + f\ln O)}{1 - adg - cd - eg} \tag{28}$$

$$\ln W = \frac{\ln X^e}{\ln \Pi^e} = \frac{d\ln\alpha}{Z} + \frac{db\ln O}{Z} + \frac{\ln\beta}{Z} + \frac{(ad+e)(\ln\gamma + f\ln O)}{Z} \tag{29}$$

where $Z = dg(\ln\alpha) + b\ln O + g\ln\beta + (1-cd)(\ln\gamma + f\ln O)$ or

$$Z(O) = \mathrm{dg}(\ln\alpha) + \mathrm{g}\ln\beta + (1-\mathrm{cd})\ln\gamma + (\mathrm{f}(1-\mathrm{cd}) + \mathrm{b})\,\mathbf{\ln O}$$

$$\mathbf{\ln W} = \frac{\ln\beta + (\mathrm{ad}+\mathrm{e})(\ln\gamma) + \mathrm{d}\ln\alpha}{\mathrm{Z(O)}} + \frac{(\mathrm{db} + \mathrm{f}(\mathrm{ad}+\mathrm{e}))}{\mathrm{Z(O)}}\,\mathbf{\ln O} \tag{30}$$

$$\frac{d}{d\ln O}\ln W = (db + f(ad+e))\ln O * (dg(\ln\alpha) + b\ln O + g\ln\beta + (1-cd)(\ln\gamma + f\ln O))^{-1} \tag{31}$$
$$+ \ln\beta + (ad+e)(\ln\gamma) + d\ln\alpha[dg(\ln\alpha) + b\ln O + g\ln\beta + (1-cd)(\ln\gamma + f\ln O)]^{-1}$$

$$\frac{\mathrm{d\ln}}{\mathrm{d\ln O}}\ln \mathrm{W} = \mathrm{f}(\mathrm{ad}+\mathrm{e}))] * [(\mathrm{dg}(\ln\alpha) + \mathrm{b}\ln \mathrm{O} + \mathrm{g}\ln\beta + (1-\mathrm{cd})(\ln\gamma + \mathrm{f}\ln \mathrm{O}))^{-1} \tag{32}$$
$$-[\mathrm{b} + (1-\mathrm{cd})\mathrm{f}][(\mathrm{db} + \mathrm{f}(\mathrm{ad}+\mathrm{e}))\ln \mathrm{O}] * (\mathrm{dg}(\ln\alpha) + \mathrm{b}\ln \mathrm{O} + \mathrm{g}\ln\beta + (1-\mathrm{cd})(\ln\gamma + \mathrm{f}\ln \mathrm{O}))^{-2}$$

$$\frac{\mathrm{d\ln W}}{\mathrm{d\ln O}} = \frac{1}{\mathrm{Z(O)}}\left[(\mathrm{f}(\mathrm{ad}+\mathrm{e}) - \left(\frac{1}{\mathrm{Z(O)}}(\ln\beta) + \frac{\mathrm{ad}+\mathrm{e}}{\mathrm{Z(O)}}\ln\gamma \frac{+\mathrm{df}(\mathrm{b}+(1-\mathrm{cd}))}{\mathrm{Z(O)}}\ln\alpha\right) - \frac{(\mathrm{b}+\mathrm{f}-\mathrm{fcd})(\mathrm{db}+\mathrm{fad}+\mathrm{fe})}{\mathrm{Z(O)}}\ln \mathrm{O}\right] \tag{33}$$

lower **lower** **uncertain**

$$\frac{\mathrm{d\ln W}}{\mathrm{d\ln O}} = \mathrm{u}(\mathrm{Z(O)}, \mathrm{a}, \mathrm{b}, \mathrm{c}, \mathrm{d}, \mathrm{e}, \mathrm{f}, \mathrm{g}, \alpha, \beta, \gamma) - \frac{(\mathrm{b}+\mathrm{f}-\mathrm{fcd})(\mathrm{db}+\mathrm{fad}+\mathrm{fe})\ln \mathrm{O}}{\mathrm{dg}(\ln\alpha) + \mathrm{g}\ln\beta + ((1-\mathrm{cd})(\ln\gamma)) + (\mathrm{b}+(1-\mathrm{cd})\mathrm{f})\ln \mathrm{O}} \tag{34}$$

$$\frac{\mathrm{d\ln W}}{\mathrm{d\ln O}} \propto -\frac{3}{\ln\alpha + \ln\beta}\ln \mathrm{O} \tag{35}$$

We see a similar situation with the way R&D spending as a proportion of other spending acts to changes in linear parameters. Equation (36) shows similar results – again taking similar derivatives (this time with respect to alpha). The term ln (α) remains in the denominator – with a negative term likely dominating the expression. Again, linearising this expression (by setting all the geometric expressions equal to zero), we see that such a derivative basically approaches a very small number as ln α becomes large. Thus, even though policy might significantly affect firms' cash (though alpha), their R&D spending relative to profits would peter out.

$$\frac{d\ln W^e}{d\ln\alpha}=\frac{d}{Z(\alpha)}\left(1-\frac{dg\ln\alpha}{Z(\alpha)}\right) \quad \text{so} \quad \frac{1}{(\ln\alpha)+\ln O+\ln\beta)}\left(1-\frac{\ln\alpha}{(\ln\alpha)+\ln O+\ln\beta)}\right) \qquad (36)$$

smaller **negative larger faster**

Changes in Structural Parameters. For equilibrium values of our variables, attempts to increase geometric parameters have the effect of reducing the size of Qianhaiese companies (and thus Qianhai's size). Equation (37) shows the way that equilibrium profits change as profit's growth-responsiveness to R&D spending increases (in other words, as *g* grows). In that equation, we assume – to simplify the equation – that all structural parameters grow quadratically (namely squared). Equations (38) and (39) simplify that expression. Equation (40) shows how larger exponential values of our structural parameters reduce the size of equilibrium values of our variables. In this case, no matter what happens, equilibrium profits fall – **implying that Qianhai's firms get more efficient.**

$$\frac{d\ln\Pi^e}{dg}=\frac{(2(\ln\alpha)+\ln\beta)}{-15}+\frac{6((4(\ln\alpha)+(2\ln\beta+(-3)(\ln\gamma))+(2+2(-3))\ln O)}{225} \qquad (37)$$

$$\frac{d\ln\Pi^e}{dg}=-\frac{(2\ln\alpha+\ln\beta)}{15}+\frac{6((24(\ln\alpha)+(12\ln\beta+(-18)(\ln\gamma))+(-24))\ln O)}{225} \qquad (38)$$

$$\frac{d\ln\Pi^e}{dg}=\frac{24(\ln\alpha)+12\ln\beta+(-18)(\ln\gamma))+(-24))\ln O)}{225}-\frac{30\ln\alpha+15\ln\beta)}{225} \qquad (39)$$

$$\frac{d\ln\Pi^e}{dg}=-\frac{6\ln\gamma+8\ln O+2\ln\alpha+\ln\beta}{75} \qquad (40)$$

What about profit's effect on cash? How does changing parameter *a* affect equilibrium profits? Equations (41) to (43) show the level of equilibrium profits when we assume the quadratic growth of all geometric structural parameters (namely setting all Latin letters to 2). We ignore the squaring of a negative number in the denominator – as we do not wish to explore the way that complex values affect this differential equation. Equation (44) shows the actual derivative of these profits with respect to the way that cash changes as profits increase. Plugging in our quadratic values for geometric structural parameters gives equation (45). Increases in other spending *O* increase the way that equilibrium profits rise in response to rises in cash as profits themselves rise. **Other spending thus actually encourages broader changes in the structural parameters driving our model.**

$$\ln \Pi^{e} = \frac{dg(dg(\ln \alpha) + b \ln O + g \ln \beta + (1 - cd)(\ln \gamma + f \ln O))}{(1 - adg - cd - eg)^{2}} \tag{41}$$

$$\frac{d \ln \Pi^{e}}{da} = \frac{4(4(\ln \alpha) + 2 \ln O + 2 \ln \beta + (1 - 4)(\ln \gamma + 2 \ln O))}{(-15)^{2}} \tag{42}$$

$$\frac{d \ln \Pi^{e}}{da} = \frac{4}{225}(\ln \alpha + 2 \ln \beta - 3 \ln \gamma) - 14 \ln O) \tag{43}$$

$$\frac{d \ln \Pi}{da} = \frac{1}{a^{2}}\left(\frac{\ln \beta}{d} - (\ln \alpha + b \ln O) - \frac{(1 - cd)}{dg}(\ln \gamma + f \ln O)\right) \tag{44}$$

$$\frac{d \ln \Pi^{e}}{da} = \frac{\ln \alpha + \ln \beta}{4} + \frac{\ln O}{4} \tag{45}$$

Changes in equilibrium. If we want to see how profits change in response to changes in R&D, we first need to find the equilibrium expression for profits and R&D. Equation (46) simply repeats the equilibrium solution to our model. Equation (47) shows the way that equilibrium profits change as equilibrium R&D rises (with both consisting of functions of other spending *O*). In that equation, profit's sensitivity to changes in R&D unsurprisingly declines as the magnitude of other spending *O* rises. In other words, for much of the range of the parameters in our model, **profit's responsiveness to other endogenous variables (like cash or R&D) falls as firm size and market size increases.** At the point where ($d\ln\Pi/d\ln X$)=0, we see that – at the profit maximising level of R&D – the natural log of these other spending *O* comes to equation (48). At that point, firms reach the best parameter *g* for ensuring that R&D spending passes through into equilibrium profits when they lower the geometric way profits impact on R&D, cash generation and on investment into R&D. **In other words, policy needs to ensure that R&D passes into profits without using these profits to generate more R&D and cash spending.**

$$\begin{bmatrix} \ln K^{e} \\ \ln X^{e} \\ \ln \Pi^{e} \end{bmatrix} = \frac{1}{1 - adg - cd - eg}\begin{bmatrix} 1 - eg & ag + c & a + ec \\ d & 1 & ad + e \\ dg & g & 1 - cd \end{bmatrix}\begin{bmatrix} \ln \alpha + b \ln O \\ \ln \beta \\ \ln \gamma + f \ln O \end{bmatrix} \tag{46}$$

$$\frac{d\Pi^{e}}{dX^{e}} = Q + \frac{-(ad + e)g^{2} + (1 - cd)g)}{(f + b)} \ln^{-1} O \tag{47}$$

where $Q = -(ad + e)g^{2} + (1 - cd)g)\left(\frac{1}{ag + c}\right)\ln^{-1}\beta + \left(\frac{1}{(a + ec)}\right)\ln^{-1}\gamma + \left(\frac{1}{(1 - eg)}\right)\ln^{-1}\alpha \cdot$

$$\ln O\big|_{\frac{d\Pi}{dX}=0} = \frac{(ad + e)g^{2} - (1 - cd)g)}{(f + b)Q} \tag{48}$$

$$\frac{(ad + e)g^{2} - (1 - cd)g)}{(f + b)Q} - \ln O\big|_{\frac{d\Pi}{dX}=0} = 0 \quad \text{and} \quad g = \frac{\frac{1 - cd}{(f + b)Q} \pm \left(\frac{cd - 1}{(f + b)Q}\right)^{2} - \left(\left(\frac{4(ad + e)}{(f + b)Q}\ln O\big|_{\frac{d\Pi}{dX}=0}\right)\right)}{\left(\frac{2(ad + e)}{(f + b)Q}\right)} = 0$$

so $g = \frac{\frac{1 - cd}{(f + b)Q} \pm}{\left(\frac{2(ad + e)}{(f + b)Q}\right)} + \frac{\left(\frac{cd - 1}{(f + b)Q}\right)^{2}}{\left(\frac{2(ad + e)}{(f + b)Q}\right)} - \frac{\left(\left(\frac{4(ad + e)}{(f + b)Q}\ln O\big|_{\frac{d\Pi}{dX}=0}\right)\right)}{\left(\frac{2(ad + e)}{(f + b)Q}\right)}$ and thus

$$g^* = \frac{1}{2(ad+e)}\left(1 - cd + \frac{(cd-1)^2}{Q(f+b)}\right) - 2(ad+e)\ln O\Big|_{\frac{d\Pi}{dX}=0} \tag{49}$$

Disequilibria: The Difference between Current and Equilibrium Profits

We start this section by recalling, in log form, profits earned by companies targeted by Qianhai as in equation (50) and (51). In order to find the distance between these two values, we find the difference of their squares – as shown in equation (52) and as rewritten in the subsequent unnumbered equations below. Equation (53) shows the difference D between current and equilibrium profits as the mix of parameters mostly driven by *O* and *g*.

$$\ln \Pi = \ln \gamma + f \ln O + g \ln X \tag{50}$$

$$\ln \Pi^{e} = \frac{dg(\ln \alpha + b \ln O)}{1 - adg - cd - eg} + \frac{g \ln \beta}{1 - adg - cd - eg} + \frac{(1 - cd)(\ln \gamma + f \ln O)}{1 - adg - cd - eg} \tag{51}$$

$$(\ln\Pi)^2 - (\ln\Pi^e)^2 = (\ln\gamma + f\ln O + g\ln X)^2 - \left(\frac{dg(\ln\alpha + b\ln O)}{1-adg-cd-eg} + \frac{g\ln\beta}{1-adg-cd-eg} + \frac{(1-cd)(\ln\gamma + f\ln O)}{1-adg-cd-eg}\right)^2 \tag{52}$$

$$(\ln\Pi)^2 - (\ln\Pi^e)^2 = (\ln\gamma + f\ln O + g\ln X)(\ln\gamma + f\ln O + g\ln X)$$

$$= (\ln\gamma)^2 + f^2(\ln O)^2 + g^2(\ln X)^2 + 2f\ln\gamma\ln O + 2g\ln\gamma\ln X + 2fg\ln O\ln X$$

$$-\frac{1}{(1-adg-cd-eg)^2}\begin{bmatrix}(dg\ln\alpha + b\ln O)^2 + 2dg^2\ln\beta(\ln\alpha + b\ln O) + 2dg(\ln\alpha + b\ln O)(1-cd)(\ln\gamma + f\ln O) + \\ + g^2(\ln\beta)^2 + 2g\ln\beta(1-cd)(\ln\gamma + f\ln O) + ((1-cd)(\ln\gamma + f\ln O))^2\end{bmatrix}$$

$$= (\ln\gamma)^2 + f^2(\ln O)^2 + g^2(\ln X)^2 + 2f\ln\gamma\ln O + 2g\ln\gamma\ln X + 2fg\ln O\ln X$$

$$-\frac{1}{(1-adg-cd-eg)^2}\begin{bmatrix}(dg\ln\alpha)^2 + dgb(\ln\alpha)\ln O + dgb(\ln O)(\ln\alpha) + (dgb\ln O)^2 \\ + 2dg^2\ln\beta\ln\alpha + 2bdg^2\ln\beta\ln O + 2dg(\ln\gamma\ln\alpha - cd\ln\gamma\ln\alpha + b\ln\gamma\ln O - bcd\ln\gamma\ln O \\ + f\ln O\ln\alpha - cdf\ln O\ln\alpha + bf(\ln O)^2 - bcdf(\ln O)^2) + \\ + g^2(\ln\beta)^2 + 2g\ln\beta((\ln\gamma + f\ln O) - cd(\ln\gamma + f\ln O)) + (1 - 2cd - (cd)^2)(\ln\gamma)^2 + (2f - 4cdf - 2f(cd)^2)((\ln\gamma)(\ln O)) \\ + 2cdf^2 - (cdf)^2 + f^2)(\ln O)^2\end{bmatrix}$$

$$= (\ln\gamma)^2 + f^2(\ln O)^2 + g^2(\ln X)^2 + 2f\ln\gamma\ln O + 2g\ln\gamma\ln X + 2fg\ln O\ln X$$

$$-\frac{1}{(1-adg-cd-eg)^2}\begin{bmatrix}d^2g^2(\ln\alpha)^2 + g^2(\ln\beta)^2 - (1 - 2cd - c^2d^2)(\ln\gamma)^2 + d^2g^2b^2 + (2f^2dgb(1-cd) + f)(\ln O)^2 \\ + 2dg^2(\ln\alpha)(\ln\beta) + 2dg(1-cd)(\ln\alpha)(\ln\gamma) + (2dgb + 2dgf(1-cdf))(\ln\alpha)(\ln O) \\ + 2bdg^2(\ln\beta)(\ln O) \\ + (2dgb(1-bcd) + (2f - 4cdf - 2f(cd)^2)(\ln\gamma)(\ln O) \\ + 2g\ln\beta(1-cd)\ln\gamma + 2fg\ln\beta(1-cd)\ln O \\ + f^2(2cd - c^2d^2)\end{bmatrix}$$

$$\begin{aligned}D = {} & (1 + \frac{1 - 2cd - c^2d^2}{(1-adg-cd-eg)^2})(\ln\gamma)^2 + (f^2 - \frac{(2f^2dgb(1-cd) + f)}{(1-adg-cd-eg)^2})(\ln O)^2 - (f - \frac{dgb(1-bcd) + f(1-2cd-(cd)^2))}{(1-adg-cd-eg)^2})\ln\gamma\ln O \\ & + ((\ln X)^2 - \frac{d^2(\ln\alpha)^2 + (\ln\beta)^2 + d^2b^2 + 2d(\ln\alpha)(\ln\beta) + 2bd(\ln\beta)(\ln O)}{(1-adg-cd-eg)^2})g^2 \\ & + 2(\ln\gamma\ln X - \frac{d(1-cd)(\ln\alpha)(\ln\gamma) + (db + df(1-cdf))(\ln\alpha)(\ln O) + \ln\beta(1-cd)\ln\gamma}{(1-adg-cd-eg)^2})g \\ & + 2(\ln O\ln X - \frac{\ln\beta(1-cd)\ln O}{(1-adg-cd-eg)^2})fg - \frac{f^2(2cd - c^2d^2)}{(1-adg-cd-eg)^2}\end{aligned} \tag{53}.$$

With some simplifying assumptions, this "disequilibrium distance" yields insights into the gap between current and equilibrium profits. Equation (54) shows the distance in the situation where all geometric terms equal 1 – in effect "linearizing" the distance.[276] Equation (55) shows the result when we also assume the linear parameter values equal 1. From equation (56), we solve the quadratic equation (in ln *X*) to find the value of R&D when the difference between the current and equilibrium value of profits are the same. Profits match their equilibrium value – assuming no geometric parameters – when R&D spending equals the value shown in equation (57) – or equation (58) with slight rearranging. For ln *O* of around 1.5, the R&D spending which puts this difference D at zero suddenly shots up exponentially.[277] Figure F2 shows the value of such other spending *O* where such distance suddenly starts taking off.

$$D=-\frac{1}{4}(\ln\alpha)^2-\frac{1}{4}(\ln\beta)^2+\frac{1}{2}(\ln\gamma)^2+(\ln X)^2-\frac{3}{2}\ln\gamma\ln O-\frac{1}{2}(\ln\alpha)(\ln\beta)-\frac{1}{2}(\ln\beta)(\ln O)+2\ln\gamma\ln X+2\ln O\ln X)+\frac{1}{4} \quad (54)$$

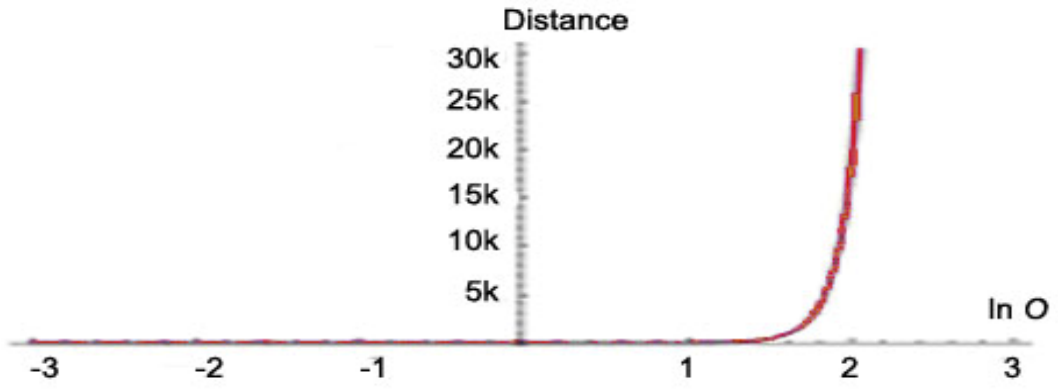
$$D=(\ln X)^2+2\ln X(1+2\ln O)-(9/4) \quad (55)$$

$$Ln(X)=(1/2)\pm\sqrt{4(1+2\ln O)^2+9}-2(1+2\ln O) \quad (56)$$

$$X=\exp(1/2)*\exp(\pm\sqrt{4(1+2\ln O)^2+9})*\exp(-2(1+2\ln O)) \quad (57)$$

$$X=\exp(-3/2)*\exp(\pm\sqrt{4(1+2\ln O)^2+9}-2\ln O)) \quad (58)$$

Figure F2: A Larger Qianhai Will Cause Larger Disequilibria as Firms Fail to Reach Equilibrium Profits Again and Again



Using quadratic values for our model's parameters shows the likely influence of another variable outside our model which influences disequilibrium distance. Equation (59) shows such a distance with geometric parameter values equal to 2. Again, if we assume unitary values for our linear parameters, we obtain equation (60). If we set this difference equal to zero (such that profits

[276] Simply setting parameters equal to one does not represent a valid method of linearizing a relationship. Purists will want to see a Power Series or similar representation of the equation, expressed around a certain point. As we want to keep our discussion relatively informal though, we do not go through the mechanics of find a linear approximation for the equation – instead playing with parameter values.

[277] Such behaviour from this function is not surprising when we observe that the term in the square root has a saddle point (which depends on parameter values). Thus, as values of other spending O move away from that saddle point, R&D spending which sets D equal to zero suddenly shoots up.

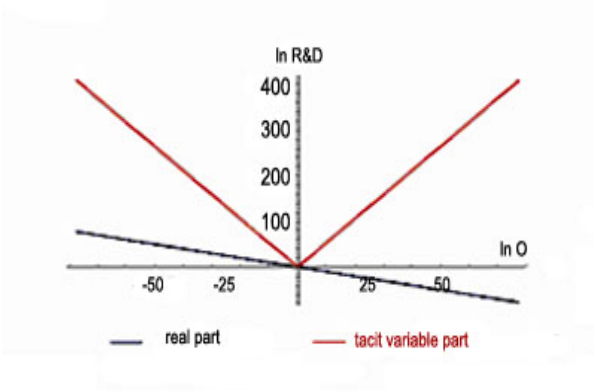
equal their equilibrium value), then we have other spending *O* define the level of R&D spending as shown in equation (61). If we can believe these results, the unknown/tacit variable *i* has roughly two times the impact as ln *O* as on ln R&D spending – and R&D spending/other spending serve as substitutes. Raising ln X by its natural exponent and plotting gives us the values shown in Figure F3.

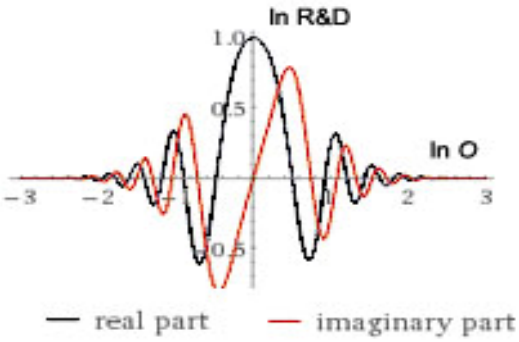
$$D=\frac{206}{225}(\ln\gamma)^2+\frac{710}{225}(\ln O)^2+(\ln X)^2-\frac{4}{225}(4(\ln\alpha)^2+(\ln\beta)^2)+\frac{16(}{225}((\ln\alpha)(\ln\beta))+2(\ln\gamma\ln X)+\frac{12}{225}(\ln\alpha)(\ln\gamma) \quad (59)$$
$$+\frac{6}{225}\ln\beta\ln\gamma+\frac{48}{225}(\ln\alpha)(\ln O)+\frac{44}{225}\ln\beta\ln O-\frac{536}{225}\ln\gamma\ln O+2(\ln O\ln X)-\frac{32}{225}$$

$$D=31.5(\ln O)^2+(\ln X)^2-2\ln O(1-\ln X)+3.85 \quad (60)$$

$$\ln X\approx 0.1(\pm\sqrt{10}\sqrt{-310(\ln O)^2+20\ln O-39}-(10\ln O)) \quad (61)$$

Figure F3: Qianhai Companies' Profits in Equilibrium Need Not Fall if R&D Spending Increases Twice as Fast as Other Spending (Until Diminishing Returns Kills Their Value)





The tacit part of ln *O* which keeps profits at their equilibrium value seems to rise half as fast as R&D.

Solutions for *X* as shown in equation (61) seem to oscillate toward zero as other spending increases.

As an aside, we note the very small difference between these models when we use linear versus quadratic exponential parameters. If equations (62) and (63) show the difference between the ln *X* predicted by each method (with each successive equation simplifying the expression), the final equation (64) – when plotted – shows differences two small even to plot.

$$Ln(X)-\ln(X)=(1/2)\pm\sqrt{4(1+2\ln O)^2+9}-2(1+2\ln O)-0.1(\pm\sqrt{10}\sqrt{-310(\ln O)^2+20\ln O-39}-(10\ln O)) \quad (62)$$

$$Ln(X)-\ln(X)=(1/2)\pm\sqrt{4+16\ln O+16(\ln O)^2)+9}-2(1+2\ln O)-0.1(\pm\sqrt{10}\sqrt{-310(\ln O)^2+20\ln O-39}-(10\ln O)) \quad (63)$$

$$Ln(X)-\ln(X)=(-3/2)+\sqrt{16\ln O+16(\ln O)^2)+13}-(0.3\sqrt{-310(\ln O)^2+20\ln O-39}-5\ln O) \quad (64)$$

The most important part of the analysis is this -- as the geometric effects of R&D on profits increase, the wider the gap will exist between market-place profits and inherent profits in equilibrium. To manage this gap, we need firms to manage their R&D spending and other spending *O*.

Qianhai's Optimal Profit Level and Market Failure as the Difference between Equilibrium and Optimal Profits

Lagrangian and first-order conditions. If we use each of our model's equations as the basis for a standard Lagrangian, then $\ell = \gamma O^{f} X^{g} + \lambda_1 (X - \beta K^{d} \Pi^{e}) + \lambda_2 (K - \alpha \Pi^{a} O^{b} X^{c})$ and Figure F4 shows the first order conditions and intermediary solutions. The optimal profit level (where asterisks indicate the optimal value of a variable) represents one of the most important aspects of the analysis. The figure also shows such optimal profits expressed in log values and the system of equations driving the optimization in an environment with so many endogenous variables.

Figure F4: Conditions for Maximising Profits in the Qianhai Region

First order conditions	Intermediary steps
$\frac{d\ell}{dX} = g\gamma O^{f} X^{g-1} + \lambda_1 (1 - d\beta K^{d-1} \Pi^{e}) - \lambda_2 (\alpha c \Pi^{a} O^{b} X^{c-1})$	$\frac{d\ell}{dX} = g\gamma O^{f} X^{g-1} + \lambda_1 (1 - d\beta K^{d-1} \Pi^{e}) - \lambda_2 (\alpha c \Pi^{a} O^{b} X^{c-1})$
$\frac{d\ell}{dK} = -\lambda_1 (\beta d K^{d-1} \Pi^{e}) + \lambda_2$	$\frac{d\ell}{d\Pi} = -\lambda_1 e \beta K^{d} \Pi^{e-1}) - \lambda_2 (a \alpha \Pi^{a-1} O^{b} X^{c})$
$\frac{d\ell}{d\Pi} = -\lambda_1 e \beta K^{d} \Pi^{e-1}) - \lambda_2 (a \alpha \Pi^{a-1} O^{b} X^{c})$	$K^{*} = \alpha \Pi^{a} O^{b} X^{c}$
$\frac{d\ell}{d\lambda_1} = X - \beta K^{d} \Pi^{e}$	$\lambda_2 = \lambda_1 (\beta d K^{d-1} \Pi^{e})$
$\frac{d\ell}{d\lambda_2} = K - \alpha \Pi^{a} O^{b} X^{c}$	$X^{*} = \beta K^{d} \Pi^{e}$

$$\Pi^{*} = \left[\left(\frac{e^2}{e^2 - d\beta} \frac{g\gamma}{\alpha c \beta d} \right) \frac{1}{\lambda_1 K^{1-d}} (O^{f} X^{g-1} - \frac{\lambda_1}{\alpha c \beta d}) \right]^{1/e}$$

$$\ln \Pi^{*} = \frac{1}{e} \ln(1 - 1 - \ln(d\beta\alpha c\beta d) + 2\lambda_1 + (1-d)K - \ln(g\gamma\alpha c\beta d) - f \ln O - (g-1) \ln X)$$

$$\begin{bmatrix} \ln(g\gamma) - \ln(\lambda_1(1 - d\beta)) \\ \ln \lambda_2 - \ln(\lambda_1 \beta d) \\ \ln(\lambda_1 e\beta) - \ln(\lambda_2 a\alpha) \\ -\ln(\beta) \\ -\ln(\alpha) \end{bmatrix} = \begin{bmatrix} (d-1) & (1-g) & e & -f \\ (d-1) & 0 & e & 0 \\ -d & c & (a-1)+(1-e) & b \\ d & -1 & e & 0 \\ -1 & c & a & b \end{bmatrix} * \begin{bmatrix} \ln K^{*} \\ \ln X^{*} \\ \ln \Pi^{*} \\ \ln O^{*} \end{bmatrix}$$

Market Failure "Distance." What is the relationship between the equilibrium level and the optimum level of these profits? Equations (65) and (66) repeat the equations for the equilibrium and optimal level of profits respectively. Rearranging these – and removing references to X and K (in order to see the optimum without the countervailing influence of K and X for the moment) gives equation (67). If equation (68) represents the difference between such equilibrium and optimal profits, then $\sqrt{D^2}$ represents the distance between the optimum and equilibrium profit and $D^2 = (\ln \Pi^{e})^2 - (\ln \Pi^{*})^2$. Yet, taking the squares and then the square root of both of equilibrium and optimal profit equations would yield a very messy expression. As such, we

describe a quasi-distance, as the simple difference between optimal and equilibrium profits. Equation (68) shows this quasi-distance as the difference between equilibrium and optimal profits.

$$\ln \Pi^{e} = \frac{dg\,(\ln \alpha + b \ln O)}{1 - adg - cd - eg} + \frac{g \ln \beta}{1 - adg - cd - eg} + \frac{(1 - cd)(\ln \gamma + f \ln O)}{1 - adg - cd - eg} \tag{65}$$

$$\ln\Pi^{*} = \frac{1}{e}\ln(1 - 1 - \ln(d\beta\alpha c\beta d) + 2\lambda_1 + (1-d)K - \ln(g\gamma\alpha c\beta d) - f\ln O - (g-1)\ln X) \tag{66}$$

$$\ln \Pi^{*} \approx \frac{1}{e}(\ln(1 - \ln(d\beta\alpha c\beta d) - \ln(g\gamma\alpha c\beta d) - \frac{f}{e}\ln O \tag{67}$$

$$\ln \Pi^{e} - \ln \Pi^{*} = D \approx \frac{g(d \ln \alpha + \ln \beta) + (1 - cd)(\ln \gamma)}{1 - adg - cd - eg} + \frac{(f - d(fc + gb)}{1 - adg - cd - eg}\ln O - \frac{1}{e}(\ln(1 - \ln(d\beta\alpha c\beta d) - \ln(g\gamma\alpha c\beta d) - \frac{f}{e}\ln O \tag{68}$$

What does this difference look like? If equations (69) simply replaces complicated jumbles of parameters for the simpler expressions *W* and *Q*, then equation (70) shows such a distance in simple terms of cash and other spending *O*. Setting such a distance *D*=0, equation (71) shows the condition – namely the values of O and K – which set equilibrium profits equal to their (static) optimal value. From that simple expression, we see that as ln *O* increases, for many parameterizations of the model, the difference between equilibrium and optimal profit levels rises. **Thus, as Qianhai gets larger, optimal profits will move farther away from equilibrium values – up to a point.**

$$D \approx \left[\frac{g(d\ln\alpha + \ln\beta) + (1-cd)(\ln\gamma)}{W} - \frac{1}{e}(\ln(1 - \ln(d^2\beta^2\alpha c) - \ln(g\gamma\alpha c\beta d))\right] + (\frac{(f - d(fc+gb) - Wf}{W})\ln O + (d-g)\ln K \tag{69}$$

for $W = 1 - adg - cd - eg$ and if $Q = \left[(g(d\ln\alpha + \ln\beta) + (1-cd)(\ln\gamma))/W - \frac{1}{e}(\ln(1 - \ln(d^2\beta^2\alpha c) - \ln(g\gamma\alpha c\beta d))\right]$

$$D = \left(\frac{(f-d)(fc+gb) - Wf}{W}\right)\ln O + (d-g)\ln K - Q \tag{70}$$

$$\ln O + (d-g)\ln K = \left(\frac{QW}{(f-d)(fc+gb) - Wf}\right) \tag{71}$$

At which point does such other spending finally stop creating a wedge between equilibrium and optimal profits? Equation (72) shows the point at which the declining effects of *O* to open the wedge between optimal and equilibrium profits finally reverses. We show the result in equation (73) in terms of the parameter most useful for Qianhai's policymakers – as the extent to which other spending *O* affects cash (and thus the size of the region as a financial centre). The simplified version in equation (74) shows the important role of parameters *b* and *g* in affecting the way other spending O affects this distance. Namely, as other spending O increases cash and increases in such cash affect profits and R&D spending affects profits. Equation (75) shows the condition under which changes in capital affect this distance. Such changes stop when **the extent to which cash affects R&D spending equals the extent to which R&D spending affects profits.**

$$\frac{dD}{d\ln O}=\left(\frac{(f-d)(fc+gb)-Wf}{W}\right) \tag{72}$$

implies $0=\frac{f^2c}{W}+\frac{fbg-fcd+gbd)}{W}-\frac{Wf}{W}$ and $0=f^2c+(bg-cd-W)f+gbd$ or

$$f=\frac{-(bg-cd-W)\pm\sqrt{(bg-cd-W)^2-4cgbd}}{2c} \tag{73}$$

$$\boxed{f=\frac{-N}{2c}\pm\frac{\sqrt{N^2-4cgbd}}{2c}} \quad \text{for } N=(bg-cd-W) \text{ and } W=(1-adg-cd-eg) \tag{74}$$

$$\frac{dD}{d\ln K}=(d-g) \quad \text{or} \quad \boxed{d=g} \tag{75}$$

What is the "natural" difference between optimal and equilibrium profits? We can look at the intercept value of this difference – before considering the impact of R&D spending or cash. Equation (76) shows the value of this distance, looking only at the terms without variables in our model. After some simplification, equation (77) shows the natural rate of such a distance – as a function of our model's parameters. Equation (78) for its part, shows the natural distance as a function of the optimal value of the other variables. For most expected levels of our model's parameters, we could expect a positive distance. Both of these observations about the natural level of market failure point to one conclusion. **Qianhai's innovative firms would never reach optimal profit levels without external intervention.**

$$\left[(g(d\ln\alpha+\ln\beta)+(1-cd)(\ln\gamma))=\frac{W}{e}(\ln(1-\ln(d^2\beta^2\alpha c)-\ln(g\gamma\alpha c\beta d))\right] \tag{76}$$

$$egd(\ln\alpha)+eg(\ln\beta)+e(\ln\gamma)-ecd(\ln\gamma)=-L(d^2\beta^2\alpha c)^W-L(g\gamma\alpha c\beta d))^W$$

$$\ln\frac{\alpha^{egd}+\ln\beta^{eg}+\gamma^e}{\gamma^{ecd}}-)=-\ln(\ln(d^2\beta^2\alpha c)^W-\ln(\ln(g\gamma\alpha c\beta d))^W$$

$$\frac{\alpha^{egd}\beta^{eg}}{\gamma^{cd}}=-(\ln(d^2\beta^2\alpha c)^W-(\ln(g\gamma\alpha c\beta d))^W \text{ and } \exp[\frac{(\alpha^d\beta)^{eg}}{\gamma^{cd}}]=\left((d\beta\alpha c)^2 g\gamma\beta d\right)^{-W} \text{ so}$$

$$\left((d\beta\alpha c)^2 g\gamma\beta d\right)=\sqrt[W]{\exp[\frac{(\alpha^d\beta)^{eg}}{\gamma^{cd}}]} \tag{77}$$

$$\boxed{\begin{aligned}D=&\frac{dg(\ln\alpha+b\ln O)}{1-adg-cd-eg}+\frac{g\ln\beta}{1-adg-cd-eg}-\ln(\frac{1}{e})+\ln\frac{1}{e}\ln(d\beta\alpha c\beta d)+\ln\frac{2\lambda_1}{e}-\ln(\frac{1}{e}\ln(g\gamma\alpha c\beta d))\\&+\left(\frac{(1-cd)(\ln\gamma+f\ln O^e)}{1-adg-cd-eg}+\ln\frac{1}{e}f\ln O^*\right)+\ln\frac{1}{e}(1-d)K^*-\ln\frac{1}{e}(g-1)\ln X^*)\end{aligned}} \tag{78}$$

What Should the Qianhai Authority's Budget Be?

The amount of money the Qianhai Authority should receive remains relatively stable – despite the method the Authority uses to prop up profits. Equation (79) shows equation (78), with the distance set to zero and rewritten as a function of our model variables. As we showed previously, the first-best approach for the Qianhai Authority consists in affecting the model parameters. Failing that, the Authority may subsidize cash, R&D or other spending *O*. As shown in equations (80), the amount of Qianhai subsidies (labelled with the sub-script G for "government") increases with Qianhai's size. Even for R&D spending expressed as a portion of cash (as shown in equation (81)), the Qianhai Authority still needs to keep up with extra spending and cash coming into Qianhai. **A Qianhai Authority must exist and make investments needed of value *D* to keep ensure that optimal profits remain above equilibrium.**

$$\ln\frac{1}{e}f\ln O^{*}+\ln\frac{1}{e}(1-d)K^{*}-\ln\frac{1}{e}(g-1)\ln X^{*})=Z \tag{79}$$

where $Z=\ln(\frac{1}{e})-\frac{dg(\ln\alpha+b\ln O)}{1-adg-cd-eg}-\frac{g\ln\beta}{1-adg-cd-eg}-\ln\frac{1}{e}\ln(d\beta\alpha c\beta d)$

$$-\ln\frac{2\lambda_1}{e}-\ln(\frac{1}{e}\ln(g\gamma\alpha c\beta d))-\frac{(1-cd)(\ln\gamma+f\ln O^{e})}{1-adg-cd-eg}$$

$$K_G-K=\sqrt[1-d]{\exp(Z)^{e}\left(\frac{X^{g-1}}{O^{f}}\right)}-K\ ,\ X_G-X=\sqrt[g-1]{\exp(Z)^{e}O^{(fe/g)}K^{(1-d)}}-X\quad O_G-O=\sqrt[f]{\exp(Z)^{e}\frac{K^{(1-d)}}{X^{(g-1)}}}-O \tag{80}$$

$$,\ \frac{X_G}{K_G}=\exp(Z)^{(2-d-g)/(1-d)}\frac{O^{f^2e/(g(1-d))}K^{(1-d)/e}}{X^{1/(e(1-d))}} \tag{81}$$

From Today's Optimum to Long-term Growth

How do optimal conditions in the Qianhai region change over time? Equation (82) shows the way that our model's variables move over time. Equation (83) shows the way that the only really exogenous variable in our model (other spending *O*) affects equilibrium growth rates. We populated this model with the b-values for the coefficients in the linearised system of equations – which are shown in equation (84) and as rearranged in equation (85).

$$\begin{bmatrix}\dot{K}\\ \dot{X}\\ \dot{P}\end{bmatrix}=\begin{bmatrix}-1 & \alpha c\Pi^{a}O^{b}X^{c-1} & \alpha a\Pi^{a-1}O^{b}X^{c}\\ \beta dK^{d-1}\Pi^{e} & -1 & \beta eK^{d}\Pi^{e-1}\\ 0 & \gamma gO^{f}X^{g-1} & -1\end{bmatrix}\begin{bmatrix}K^{*}\\ X^{*}\\ P^{*}\end{bmatrix} \tag{82}$$

$$\left[\begin{bmatrix}\alpha\Pi^{a}O^{b}X^{c}-K\\ \beta K^{d}\Pi^{e}-X\\ \gamma O^{f}X^{g}-\Pi\end{bmatrix}\right]=\begin{bmatrix}-1 & \alpha c\Pi^{a}O^{b}X^{c-1} & \alpha a\Pi^{a-1}O^{b}X^{c}\\ \beta dK^{d-1}\Pi^{e} & -1 & \beta eK^{d}\Pi^{e-1}\\ 0 & \gamma gO^{f}X^{g-1} & -1\end{bmatrix}\begin{bmatrix}df/dO\\ df/dO\\ df/dO\end{bmatrix} \tag{83}$$

$$\ln \dot{\Pi} = 0.56 + 0.25 \ln \Pi + 0.05 \text{nX} - 0.15 \ln \text{K} - 0.15 \ln \text{O} \quad (84)$$

$$\ln \dot{\text{X}} = 0.43 + 0.05 \ln \Pi + 0.06 \text{X} - 0.10 \ln \text{K} - 0.01 \ln \text{O}$$

$$\ln \dot{\text{K}} = 0.05 + 0.05 \ln \Pi - 0.0002 \text{X} - 0.003 \ln \text{K} - 0.03 \ln \text{O}$$

$$\begin{bmatrix} \ln \dot{\text{K}} \\ \ln \dot{\text{X}} \\ \ln \dot{\Pi} \end{bmatrix} = \begin{bmatrix} -0.003 & -0.002 & 0.05 \\ -0.10 & 0.06 & 0.05 \\ -0.15 & 0.05 & 0.25 \end{bmatrix} * \begin{bmatrix} \ln \text{K} \\ \ln \text{X} \\ \ln \Pi \end{bmatrix} \quad (85)$$

With these parameter estimates, we could find the values of K,X, and Π for each point in time.[278] Equation (86) shows the short-term adjustment of each of our variables. With our exogenous variable used in the analysis, equation (87) shows the steady-state (long-term) solutions – which equation (88) simplifies.[279]

$$\begin{bmatrix} \ln \text{K} \\ \ln \text{X} \\ \ln \Pi \end{bmatrix} = \begin{bmatrix} 0.2e^{0.226t} & 0.37e^{0.073t} & 0.5e^{0.008t} \\ 0.16e^{0.226t} & -7.67e^{0.073t} & 0.85e^{0.008t} \\ 0.96e^{0.226t} & 0.53e^{0.073t} & 0.14e^{0.008t} \end{bmatrix} \text{ for adjustment (short-term)} \quad (86)$$

$$\begin{bmatrix} -0.05 + 0.03 \ln \text{O} \\ -0.43 + 0.01 \ln \text{O} \\ -0.56 + 0.15 \ln) \end{bmatrix} = \begin{bmatrix} -0.003 & -0.002 & 0.05 \\ -0.10 & 0.06 & 0.05 \\ -0.15 & 0.05 & 0.25 \end{bmatrix} * \begin{bmatrix} \ln \text{K} \\ \ln \text{X} \\ \ln \Pi \end{bmatrix} \quad (87)$$

$$\begin{bmatrix} \ln \text{K} \\ \ln \text{X} \\ \ln \Pi \end{bmatrix} = \begin{bmatrix} 7.87 & -1.127 \ln \text{O} \\ -1.06 & -0.634 \ln \text{O} \\ -0.085 & 0.03 \ln \text{O} \end{bmatrix} \quad (88)$$

The steady-state growth rate of the Qianhai region came from a few more equations. Equation (89) shows the matrix of variables which change over time. Equation (90) simplifies the equations (whose parameter estimates we obtained from the regression analysis described in another appendix). Equation (91) shows the growth of our variables expressed as a function of the exogenous variable, namely other spending *O*.[280]

$$\ln \dot{\Pi} = -0.03 + .4 \ln \dot{\text{X}} - 0.13 \ln \dot{\text{K}} + 0.07 \ln \dot{\text{O}} \quad (89)$$

$$\ln \dot{\text{X}} = 0.20 + 0.035 \ln \dot{\Pi} + 0.26 \ln \dot{\text{K}} + 0.11 \ln \dot{\text{O}}$$

$$\ln \dot{\text{K}} = 0.07 - 0.007 \ln \dot{\Pi} + 0.166 \ln \dot{\text{X}} + 0.08 \ln \dot{\text{O}}$$

[278] The exact procedure involved finding the eigenvalues and eigenvectors of the matrix shown. The eigenvalues served as the coefficient on the Euler constant (e), while eigenvectors represented the coefficients in front of each e-value.

[279] We found these solutions using Cramer's Rule to solve for each variable.

[280] We specifically used Cramer's Method to solve for each of the variables.

$$\begin{bmatrix} 0.03-0.07\ln\dot{O} \\ -0.20-0.11\ln\dot{O} \\ -0.07-0.08\ln\dot{O} \end{bmatrix} = \begin{bmatrix} -0.13 & 0.4 & -1 \\ 0.26 & -1 & 0.035 \\ -1 & -0.166 & -0.007 \end{bmatrix} * \begin{bmatrix} \ln\dot{K} \\ \ln\dot{X} \\ \ln\dot{\Pi} \end{bmatrix} \quad (90)$$

$$\begin{bmatrix} \ln\dot{K} \\ \ln\dot{X} \\ \ln\dot{\Pi} \end{bmatrix} = \begin{bmatrix} 0.04+0.06\ln\dot{O} \\ 0.22+0.13\ln\dot{O} \\ 0.05+0.12\ln\dot{O} \end{bmatrix} \quad (91)$$

Finding Optimal Growth Rates (Euler Equation). We found the profits max out as follows. Equation (92) shows the Euler equation (equation of motion) whose parameter estimates came from the econometric analysis we described previously. The equations below that show the steps for finding the optimal over time. After rearranging and solving, equation (93) shows the R&D spending which solves the associated equation. As a function of time, equations (94) and (95) show such profit as a function of time. Figure F5 shows more in-depth analysis of the behaviour of such profits over time. Solving for profits 5 years in advance (namely where t=6, we see a solution of $-05c_1-0.008c_2+3$ – for initial conditions which depend on which year we use to start our calculations. Optimal R&D spending decrease profits in the short-term then increase as they work through the system. **The optimal condition comes to profits maximised as R&D spending increases by magnitude of 0.6 of profits every year.**

$$\ln\dot{\Pi} = 80+.57\ln\dot{X}+0.32\ln\dot{K}+0.19\ln\dot{O}+1.95\Pi+0.1\ln X+0.16\ln K-1.65\ln O \quad (92)$$

$$\dot{\Pi} = \frac{80\dot{X}^{0.57}\dot{K}^{0.32}\dot{O}^{0.19}\Pi^{1.95}X^{0.1}K^{0.1}}{O^{1.65}}$$

$$\frac{8\dot{X}^{0.57}\dot{K}^{0.32}\dot{O}^{0.19}\Pi^{1.95}X^{-0.9}K^{0.1}}{O^{1.65}} = \frac{45.6\dot{X}^{-0.43}\dot{K}^{0.32}\dot{O}^{0.19}\Pi^{1.95}X^{0.1}K^{0.1}}{O^{1.65}}$$

$$\frac{8\dot{X}^{0.57}\dot{K}^{0.32}\dot{O}^{0.19}\Pi^{1.95}X^{-0.9}K^{0.1}}{O^{1.65}} = \frac{d}{dt}\frac{45.6\dot{X}^{-0.43}\dot{K}^{0.32}\dot{O}^{0.19}\Pi^{1.95}X^{0.1}K^{0.1}}{O^{1.65}}$$

$$\frac{8\dot{X}^{0.57}\dot{K}^{0.32}\dot{O}^{0.19}\Pi^{1.95}X^{-0.9}K^{0.1}}{O^{1.65}} = \frac{45.6\ddot{X}^{-0.43}\dot{K}^{0.32}\dot{O}^{0.19}\Pi^{1.95}\dot{X}^{0.1}K^{0.1}}{O^{1.65}}$$

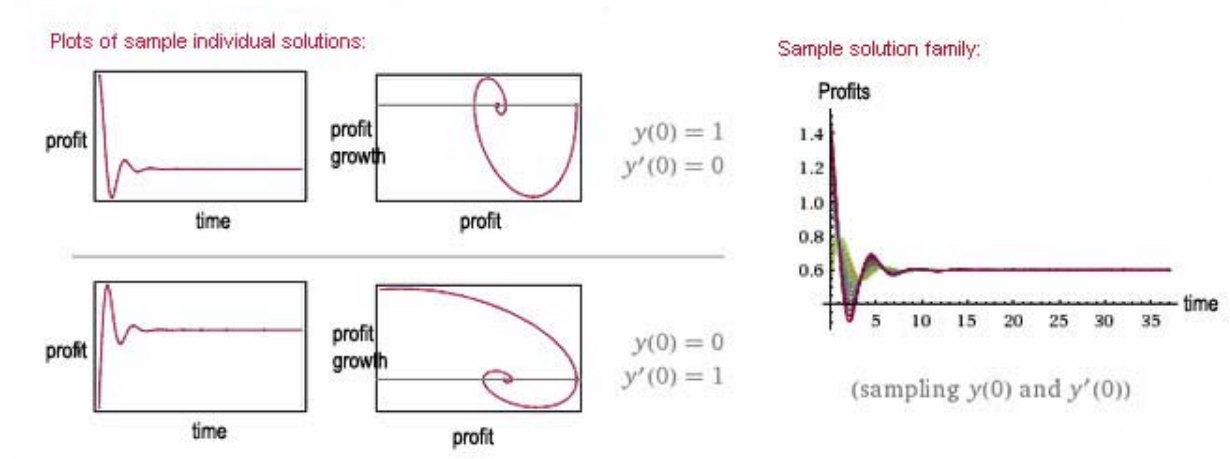
$$\frac{\dot{X}^{0.57}X^{-0.9}}{\ddot{X}^{-0.43}\dot{X}^{0.1}} = 5.73 \quad \frac{\ddot{X}^{0.43}\dot{X}^{0.47}}{X^{0.9}} = 5.73 \quad 0.43\ln\ddot{X}+0.47\ln\dot{X}-0.9\ln X = 5.73$$

$$X^* = 1.8c_1(-0.5t)e^{\sin(t^{1.3})}c_2(-0.5)e^{\cos(t^{1.3})} \quad (93)$$

$$\int(\ln\dot{\Pi})dt = e^{-0.5t}((.067c_2-0.25c_1)\sin(1.3t)+(-0.67c_1-0.25c_2)\cos(1.3t)+0.6e^{0.5t}t)) \quad (94)$$

$$\left[\int(\ln\dot{\Pi})dt\right]_0^5 = 0.45c_2c_1\int x^2\exp\hat{}[\sin(t^{1.3})+\cos(t^{1.3})dt \approx 18 \quad (95)$$

Figure F5: Time Path of Profits in the Qianhai Region Predicted by Our Model



Structural reform cases in dynamic analysis. How does the status quo compare with the case when the Qianhai Authority encourages the structural reform of innovation – as we have previously discussed? Equation (96) shows our model's structural equations with "better" structural parameters (values which lead to more profits, less money needed, less R&D needed, etc.). Equation (98) shows the short-term solutions.[281] Setting the system to the intercepts we ignored in the previous equation, equation (99) shows solutions for the system of equations portrayed in equation (98). Equation (100) shows another scenario – where we have shown the simulated effect of parameter changes in our paper. Needless to say, equation (101) shows the different solutions as a function of changes in other spending *O*. Even the Euler equation used to optimize profits changes, as shown in equation (102). We already demonstrated the method of solving these kinds of equations – thus we do not repeat the solutions again.

$$\ln \dot{\Pi} = 0.56 + 0.50 \ln \Pi + 0.2 \ln X - 0.25 \ln K - 0.05 \ln O \tag{96}$$

$$\ln \dot{X} = 0.43 + 0.05 \ln \Pi + 0.06 \ln X + 0.10 \ln K - 0.01 \ln O$$

$$\ln \dot{K} = 0.05 + 0.25 \ln \Pi + 0.05 \ln X + 0.01 \ln K - 0.01 \ln O$$

$$\begin{bmatrix} \ln \dot{K} \\ \ln \dot{X} \\ \ln \dot{\Pi} \end{bmatrix} = \begin{bmatrix} 0.01 & 0.05 & 0.25 \\ 0.10 & 0.06 & 0.05 \\ 0.25 & 0.05 & 0.25 \end{bmatrix} * \begin{bmatrix} \ln K \\ \ln X \\ \ln \Pi \end{bmatrix}$$

$$\begin{bmatrix} \ln K \\ \ln X \\ \ln \Pi \end{bmatrix} = \begin{bmatrix} 0.52e^{0.43t} & 0.83e^{-0.15t} & 0.03e^{0.05t} \\ 0.25e^{0.43t} & -0.27e^{-0.15t} & -e^{0.05t} \\ 0.81e^{0.43t} & -0.50e^{-0.15t} & 0.2e^{0.05t} \end{bmatrix} \tag{97}$$

[281] The system ignores intercepts and exogenous variables, which we include in the long-term analysis below.

$$\begin{bmatrix} -0.05+0.01\ln O \\ -0.43+0.01\ln O \\ -0.56+0.05\ln O \end{bmatrix} = \begin{bmatrix} 0.01 & 0.05 & 0.25 \\ 0.10 & 0.06 & 0.05 \\ 0.25 & 0.05 & 0.25 \end{bmatrix} * \begin{bmatrix} \ln K \\ \ln X \\ \ln \Pi \end{bmatrix} \quad (98)$$

$$\begin{bmatrix} \ln K \\ \ln X \\ \ln \Pi \end{bmatrix} = \begin{bmatrix} 7.87 & -1.127\ln O \\ -1.06 & -0.634\ln O \\ -0.085 & 0.03\ln O \end{bmatrix} \quad (99)$$

$$\ln \dot{\Pi} = -0.03 + .4\ln \dot{X} - 0.13\ln \dot{K} + 0.07\ln \dot{O}$$
$$\ln \dot{X} = 0.20 + 0.035\ln \dot{\Pi} + 0.26\ln \dot{K} + 0.11\ln \dot{O} \quad (100)$$
$$\ln \dot{K} = 0.07 - 0.007\ln \dot{\Pi} + 0.166\ln \dot{X} + 0.08\ln \dot{O}$$

$$\begin{bmatrix} 0.03-0.07\ln \dot{O} \\ -0.20-0.11\ln \dot{O} \\ -0.07-0.08\ln \dot{O} \end{bmatrix} = \begin{bmatrix} -0.13 & 0.4 & -1 \\ 0.26 & -1 & 0.035 \\ -1 & -0.166 & -0.007 \end{bmatrix} * \begin{bmatrix} \ln \dot{K} \\ \ln \dot{X} \\ \ln \dot{\Pi} \end{bmatrix}$$

$$\begin{bmatrix} \ln \dot{K} \\ \ln \dot{X} \\ \ln \dot{\Pi} \end{bmatrix} = \begin{bmatrix} 0.04+0.06\ln \dot{O} \\ 0.22+0.13\ln \dot{O} \\ 0.05+0.12\ln \dot{O} \end{bmatrix} \quad (101)$$

$$\ln \dot{\Pi} = 80 + .57\ln \dot{X} + 0.32\ln \dot{K} + 0.19\ln \dot{O} + 1.95\Pi + 0.1\ln X + 0.16\ln K - 1.65\ln O \quad (102)$$