

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

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Abstract

How many innovation-led profits could Qianhai – an innovation park in Shenzhen – generate for Hong Kong, Shenzhen and in the ‘Qianhai region’? In this paper, we develop a model of profit-led innovation, and use it to deduce how many profits Qianhai could help foster. 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 (4) in the short-run and a factor of ten (10) in the longer run. However, such profits depend on deep, fundamental changes in the regulations governing Qianhai - and by implication, Hong Kong and Shenzhen. The current design seems unlikely to produce any benefits.

JEL Codes: P48, R12, R58,

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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 policies 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 in the region redraft their 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

We must highlight several caveats before we start our main exposition. First, and most importantly, we only have the space to present the findings of a larger study here. Such space constraints limit our ability to provide a separate literature review, a review of the policies we simulate, and all of our 'intermediate steps.'⁵ In this way, our paper serves more as a poster or review - rather than a full exposition of our work. We beg the reviewers' and readers' indulgence -- as we sacrifice discussing the technical issues in favour of producing a readable narrative.

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."

⁵ For the full study, see **REMOVED TO PRESERVE ANONYMITY**.

Second, we avoid comparing Qianhai with other jurisdictions - taking the region on its own terms.⁶ Indeed, we take a completely normative (rather than positive) approach - describing a Qianhai we may never see. Such an approach involves ignoring the politics of such reform as well.⁷

Most importantly and damning, we only address the literature (in this paper) parenthetically in footnotes. We can only here claim that the literature often assumes the positive effects of innovation policy, without actually addressing the profit motive - with notable exceptions like Huang and Hou (2019), whose study even uses the same methods we do. For example, studies from Zhu (1994) to Guan and Yam (2015) claim innovation policy impacts on companies' and innovation zone tenants, without ever actually quantifying such benefits. We can not understand how other authors can draw their conclusions without understanding (at least) the magnitude of effects on profits. We refer the reader to our literature review for a fuller motivation.

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 1, 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.⁸ 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.⁹ **Profits** represent the most important variable – the thing we actually care most about.¹⁰ 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.**¹¹

⁶ A vast literature exists showing special economic zones how to supposedly import lessons from other jurisdictions. Block and Keller (2011) show how government agencies in the US helped foster technological innovation. Klerkx and Leeuwis (2009) describe the challenges for government agencies to encourage private agricultural enterprises to adopt innovative practices in the Netherlands.

⁷ Moberg (2015) provides a useful theoretical overview, while Yu and Aggarwal (2020) provide a description in the Chinese context.

⁸ Authors like Qiu and Wan (2015) have already found that innovation encourages firms to defensively hold cash to address unknown risks.

⁹ Colombo *et al.* (2013) show the fragility of such an effect, while Brown and his co-authors (2009) find that cash may encourage some firms (young ones) to invest in R&D, but not older firms.

¹⁰ While we claim that the literature does not address profits directly, papers like Sun *et al.* (2020) look at the effects of specific policies or incentives

¹¹ We also thus have no interest in the important spillover effects which could determine a fair share of these profits - an effect Guo (2005) points to clearly.

Following authors like Savignac (2008), 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. But we don’t include them in our formal analysis. We describe how we deal with, and interpret, these variables in Figure 2.

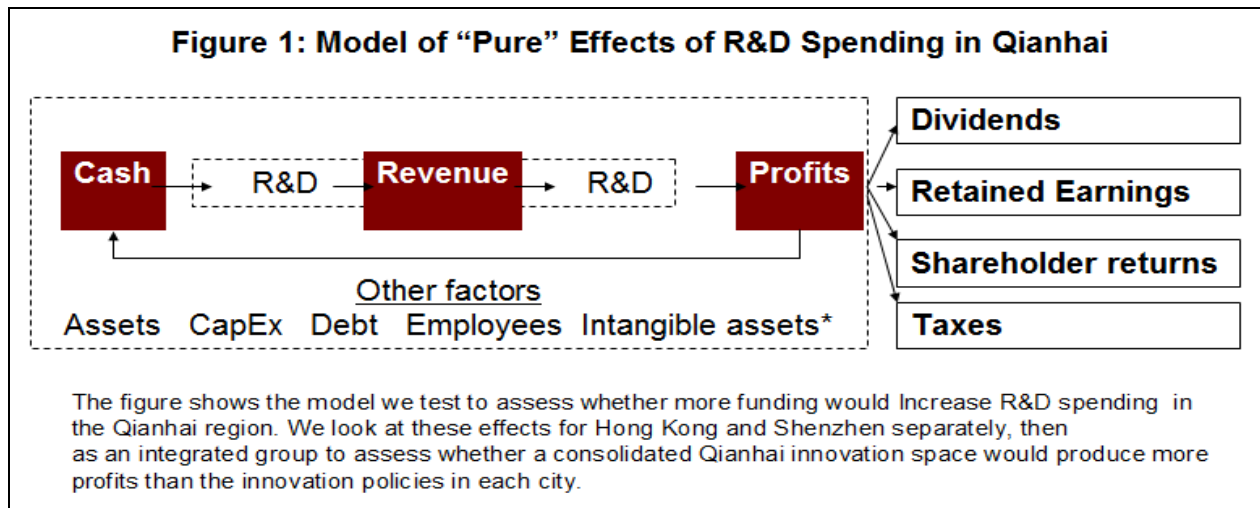


Figure 2: Procedures Used at a Glance for Qianhai Study
(layperson’s summary of Appendix IV)

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. These are available online.

What Affects Our Model Variables?

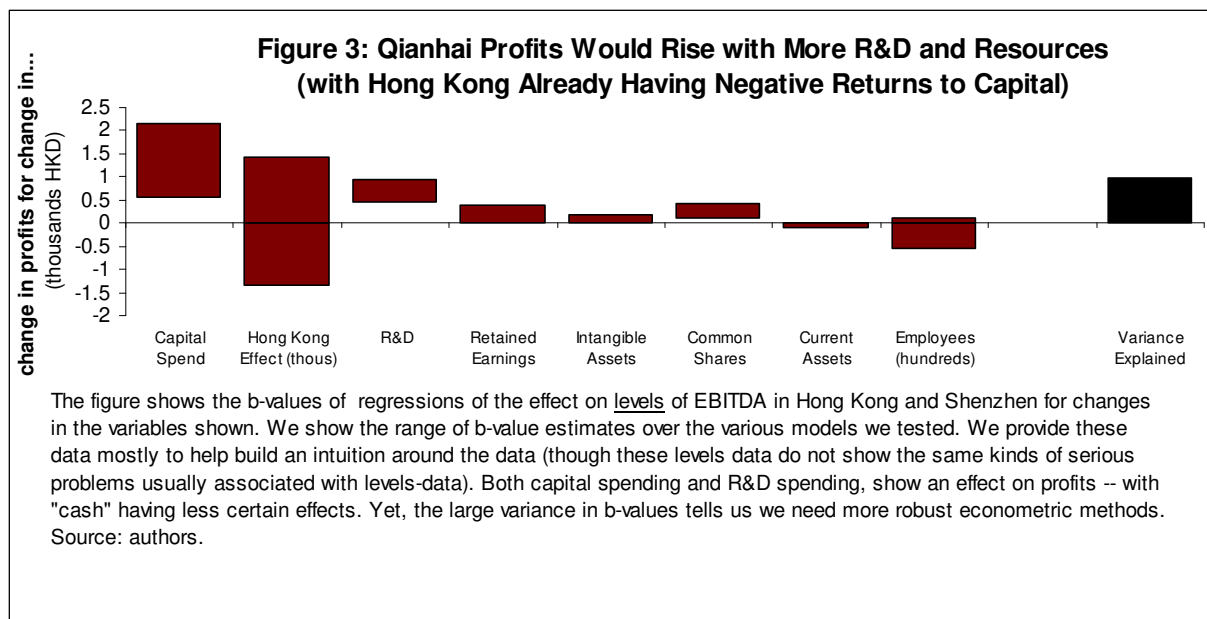
What affects the profits of innovation-oriented companies in the Qianhai region? Figure 3 shows the simple-minded regression of various factors on profits. Capital spending had the largest effect on profits – with the estimated effect of changes in capital spending on profits varying between 1 and 2, depending on the model used.¹² 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\$2,000.¹³ 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.¹⁴ The very “good” explanatory power of the regression (with an adjusted R-squared of around 0.90) in itself tells us little.¹⁵

¹² Such a finding supports Hirshleifer’s et al.’s (2017) finding of investment in innovation in the Hong Kong region as a way of creating “competitive moats.”

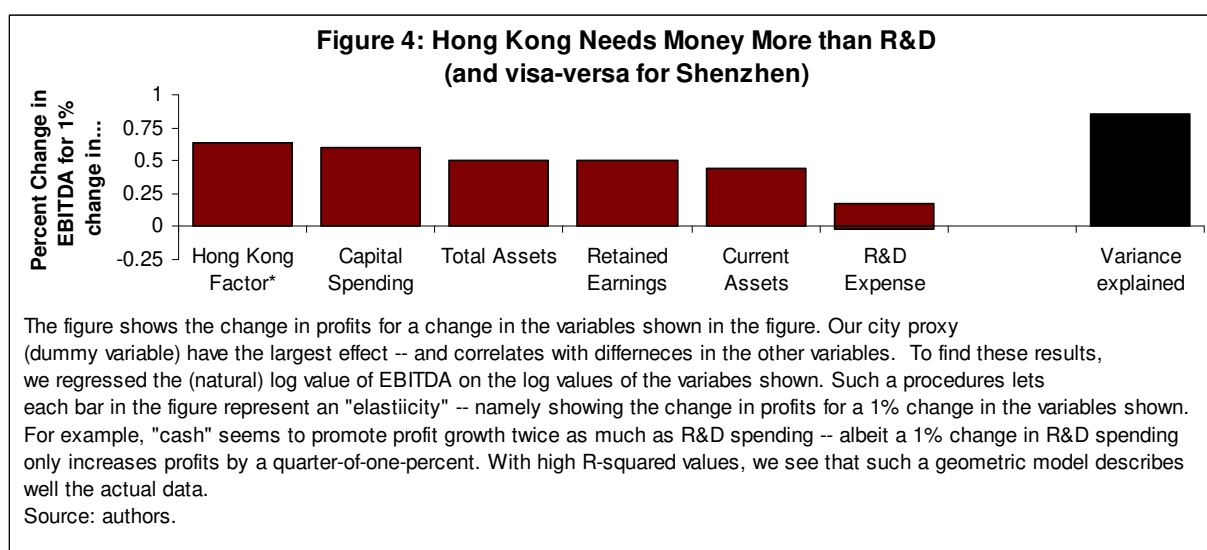
¹³ We do not continue to put an HK before the dollar sign, to make the text easier to read. Unless we note otherwise, readers can assume that all values presented in this section relate to Hong Kong dollars.

¹⁴ An unsurprising finding, given authors’ like Cozza et al.’s (2012) findings that small firms can have an “innovation premium.” Coad et al.’s (2013) finding shows how innovative firms’ profitability can improve with time.

¹⁵ 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.

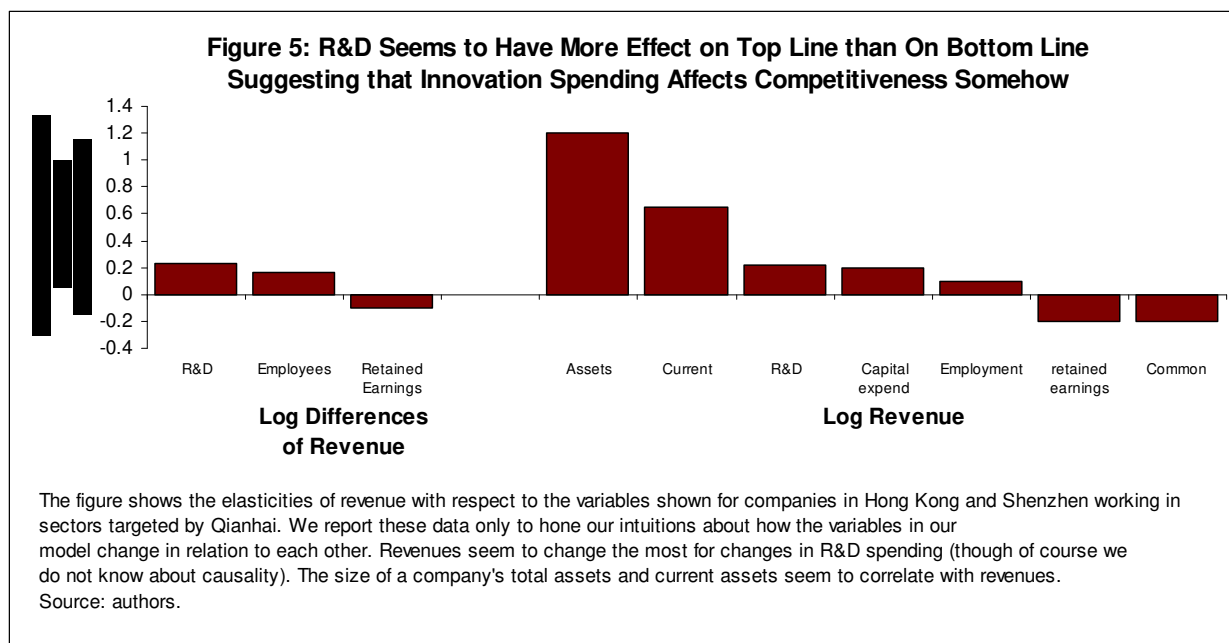


Econometric work using growth models – rather than the simple linear model reported above – adds credence to these initial findings. Figure 4 shows the results of similar regression work, this time better targeting the geometric growth in profits, R&D spending and cash. In this better model, a firm’s 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.



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. 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. Method of moments estimation shows the very strong influence of long-term debt on “pure profits.”¹⁶ 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 5 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).**¹⁷

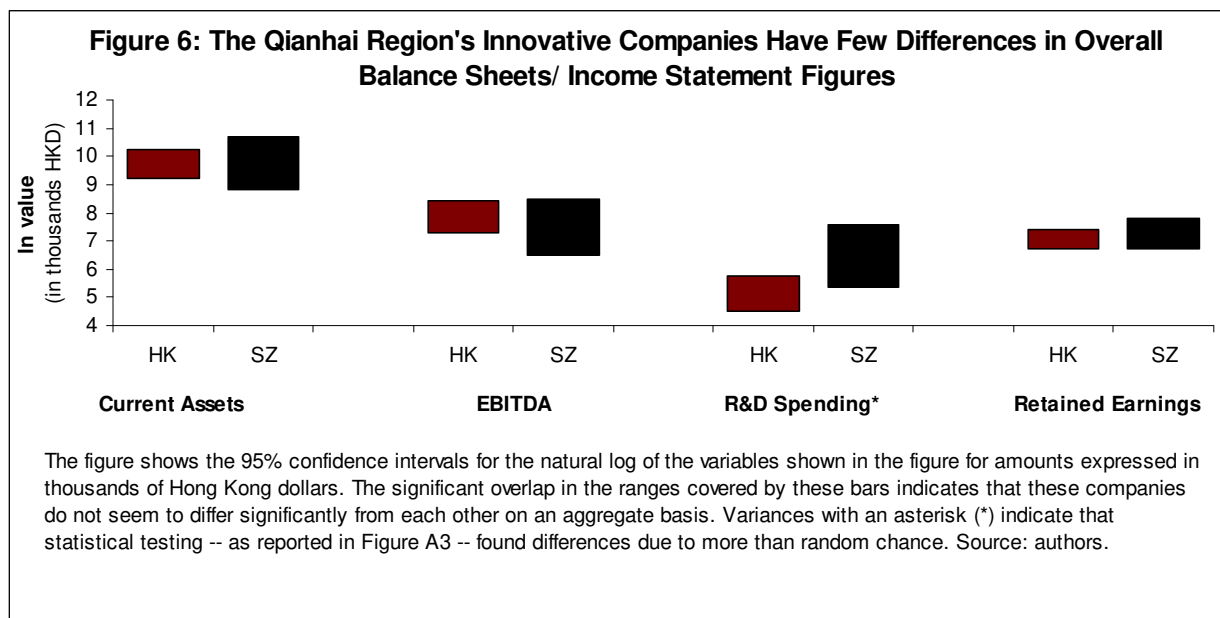


¹⁶ “Method of moments” refers to a generalisation of linear regression, which takes care of non-linearities, heteroskedasticity, endogeneity and other problems. Arellano (2002) provides a good overview for readers unfamiliar with the procedure. As described previously, we constructed and used a measure 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.

¹⁷ Hardly a new finding, something Calcagnini and his co-authors (2015) found years ago. As we note in our literature review (provided online), universities - like Hong Kong’s and Shenzhen’s - attract such innovative firms.

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 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.¹⁸ 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. The most sophisticated analysis confirms these effects – and the sizeable impact of profit/R&D on cash.¹⁹ In isolation, these results suggest that Hong Kong needs Shenzhen much more than Shenzhen needs Hong Kong.²⁰

A detailed look at city-level data suggest that the relationships illustrated above describes Hong Kong about as well as Shenzhen. Figure 6 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 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.²¹



¹⁸ Namely cash like current assets fall by \$1 for every 0.5 to 1 drop in EBITDA.

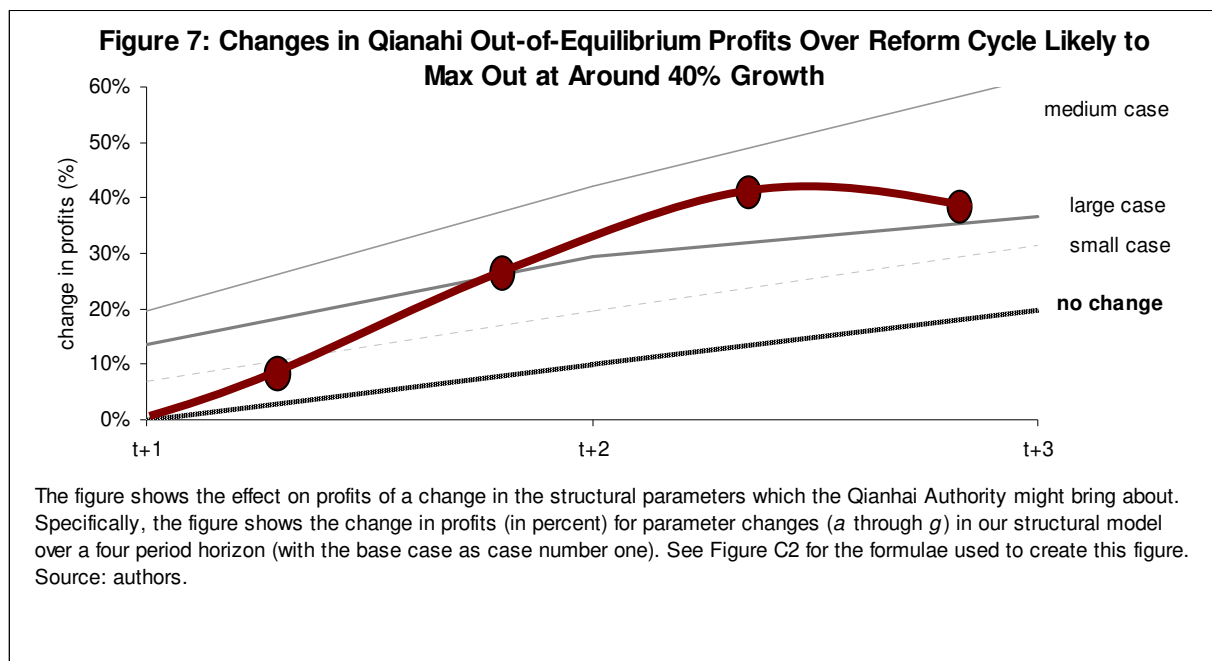
¹⁹ We can not know the size of the effect from this analysis – as method of moments type tests the scale of effect size by using the variance of the relevant variables involved.

²⁰ A finding which confirms studies by the likes of Fu et al. (2012), specifically for Shenzhen.

²¹ 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 7 shows the effect of reforms we recommended earlier in this paper – but only for the short-run.²² 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.²³ 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.



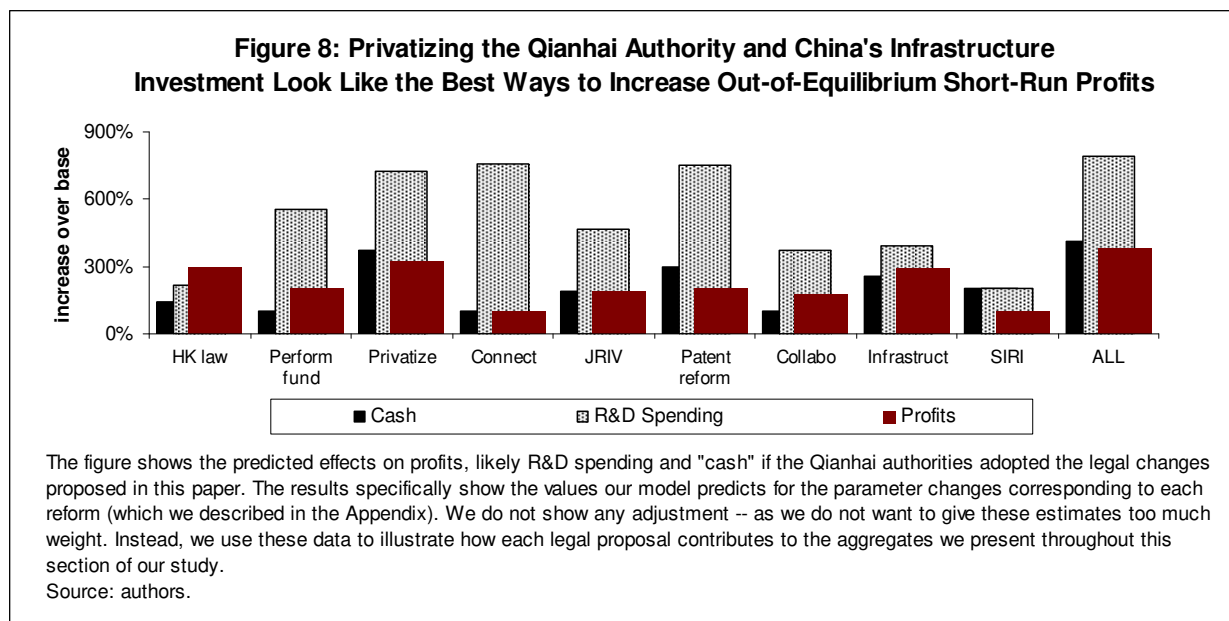
The figure also shows us several interesting things about the way innovation and policy reform promotes growth, even outside the Qianhai context. First, even with no change in policy, growth continues in an upward direction – not just profits, but the growth of those profits themselves... at least in 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

²² We have used our basic model, assumed that Qianhai Authority policy changes each of the parameters as we describe in our larger working paper, and modelled the extent to which the Authority pursues these reforms by higher parameter values. 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.

²³ Again assuming no harmful political effects (Gustafsson et al., 2016).

over and growth rates plummet.²⁴ 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.

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 8 shows the estimated impacts on profits of each of the major areas of reform which we propose.²⁵ 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 specific 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.**



What effect would simply giving more resources to innovative companies have on Qianhai-region profits? As authors like Bellucci and her colleagues (2019) show, much existing policy aims at showering start-ups and other companies with resources in the hopes of overcoming some kind of start-up externality.²⁶ Figure 9 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

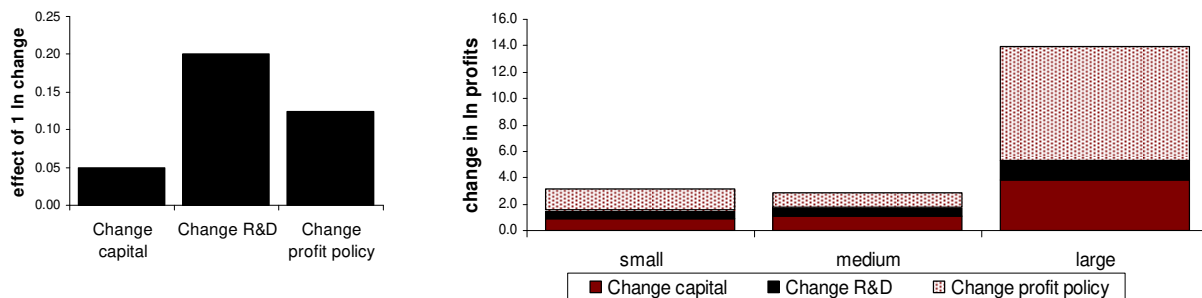
²⁴ For the mathematically minded, as our parameters like a , b and so on reach 1 or higher, changes from the previous period become less. As a result, growth “slows” – even if such reform actually improves long-term profit prospects.

²⁵ 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.

²⁶ They specifically find that targeted subsidization has larger effects on individual firm performance, whereas in regional, sector-based support affects mostly employment and overall R&D expenditure.

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” as we have defined them.²⁷ For now, increasing spending on R&D provides the best kind of direct-support – though structural reform generates far more profitable innovation than simply dumping resources on Qianhai region companies.

Figure 9: 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 10 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.²⁸ 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.**

²⁷ 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).

²⁸ 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 10: 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.

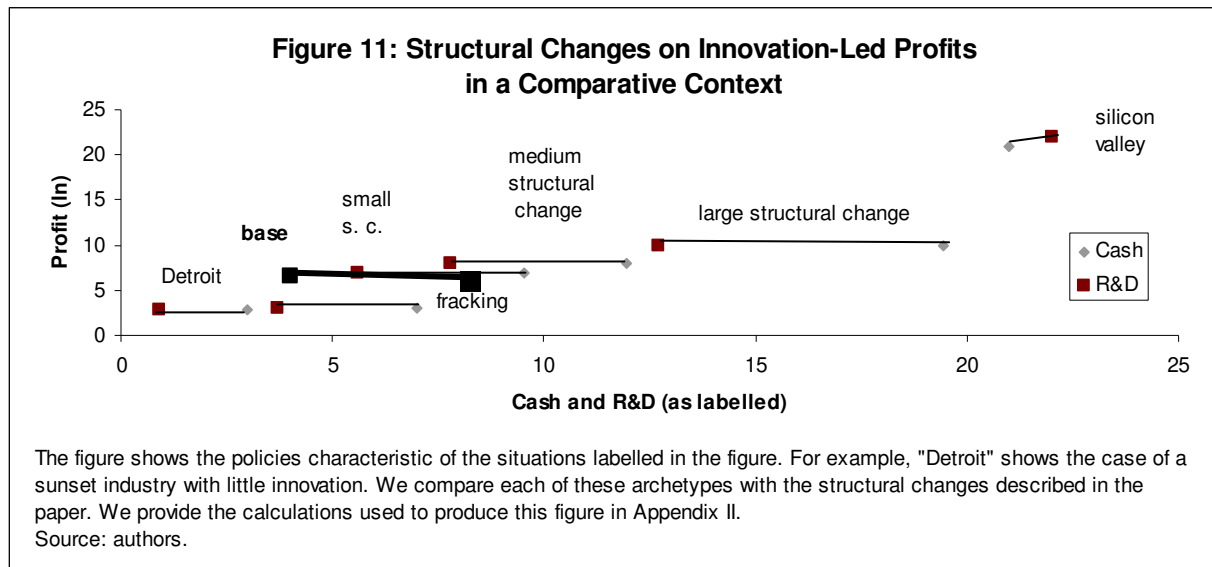
Finding and Changing Equilibrium Profits for the Qianhai region

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.²⁹ Figure 11 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. 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).³⁰ Qianhai’s companies’ profits remain far lower than in the Silicon Valley case we describe in the

²⁹ The figure shows the magnitude of profits compared with the magnitude of other spending (as the natural log or ln represents this magnitude).

³⁰ 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.

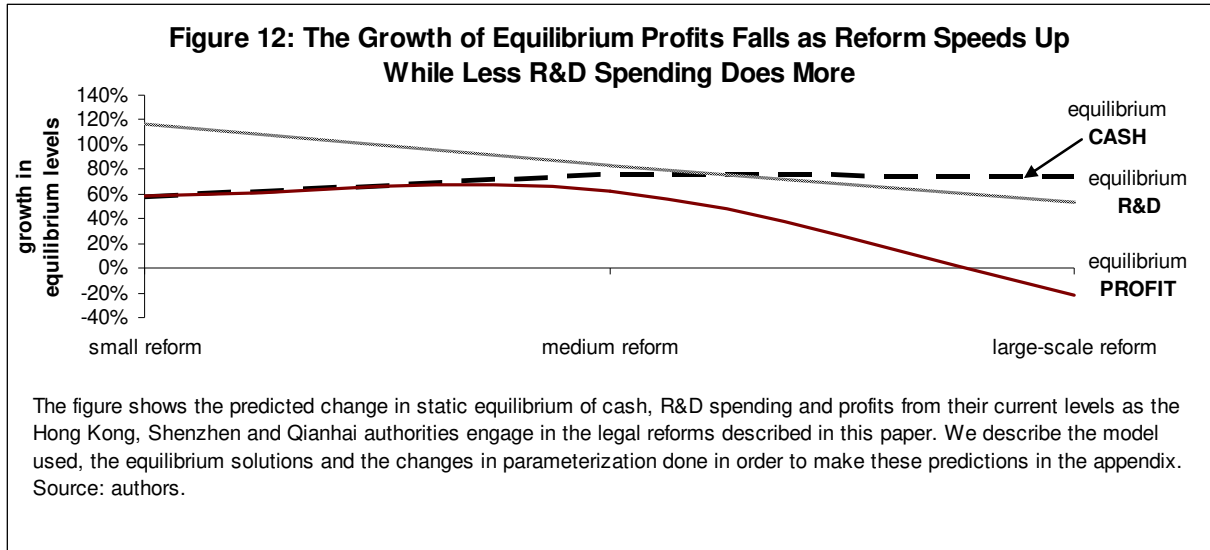
appendix. The astute reader will note that even with reform, Qianhai companies will require more and more money to squeeze more profits out.³¹



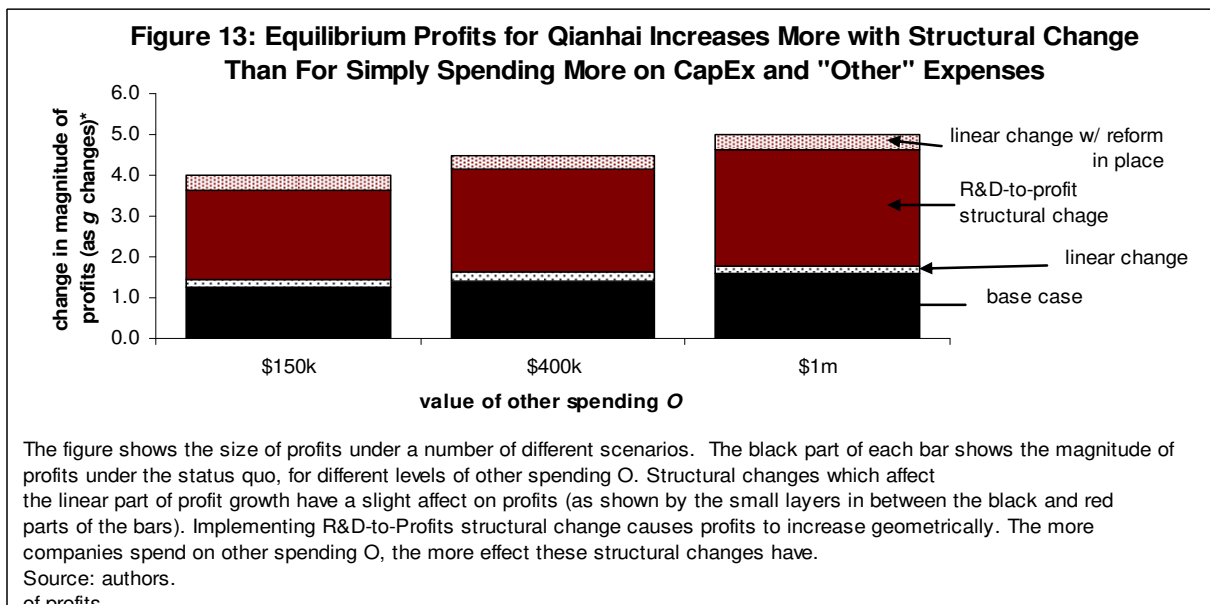
Unsurprisingly, legal reforms aimed at increasing the profitability of Qianhai's innovative companies suffers from diminishing returns. Figure 12 shows the growth rates of equilibrium profits, cash and R&D for the three cases corresponding to the extent of legal reform adopted by the Qianhai region's 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 in equilibrium, thereby undermining the entire innovation-led reform.³²

³¹ 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).

³² Such a finding coincides with studies like Cherkasova and Kurlyanova (2019) which show that overinvestment in research can hurt as much as underinvestment.

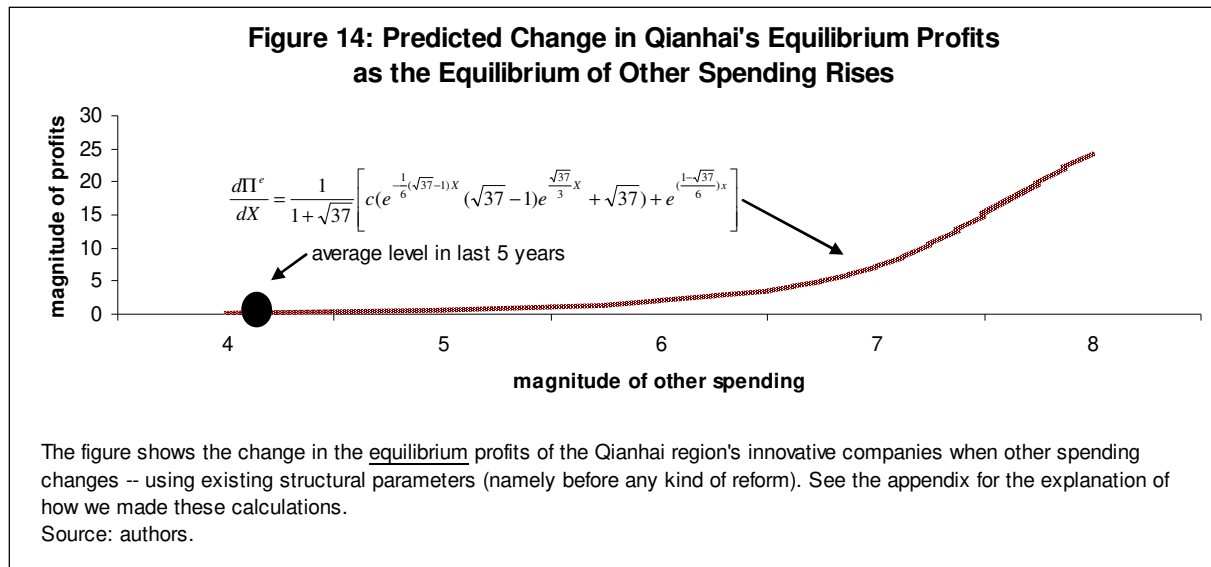


As with the out-of-equilibrium case, the right amount of structural reform will benefit Qianhai’s innovative companies far more than simply spending more on capex or “other” spending. Figure 13 shows the change in profits accruing from the legal/structural changes we previously advocated, making R&D 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.³³ 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.



³³ 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 14 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. 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.³⁴ 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!

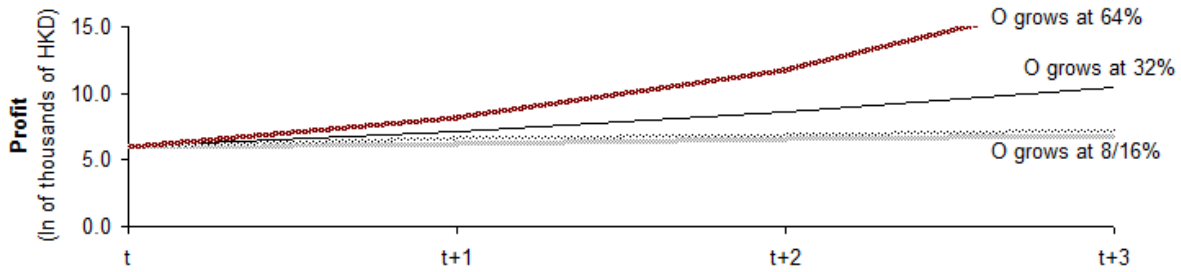


How fast would the adjustment take? How fast would average equilibrium profits grow in response to changes in the growth of these other expenses? Figure 15 shows our model’s predictions for the growth in the levels of profits corresponding growth rates of other expenses.³⁵ Growth rates of other spending 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.

³⁴ “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 .

³⁵ 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.

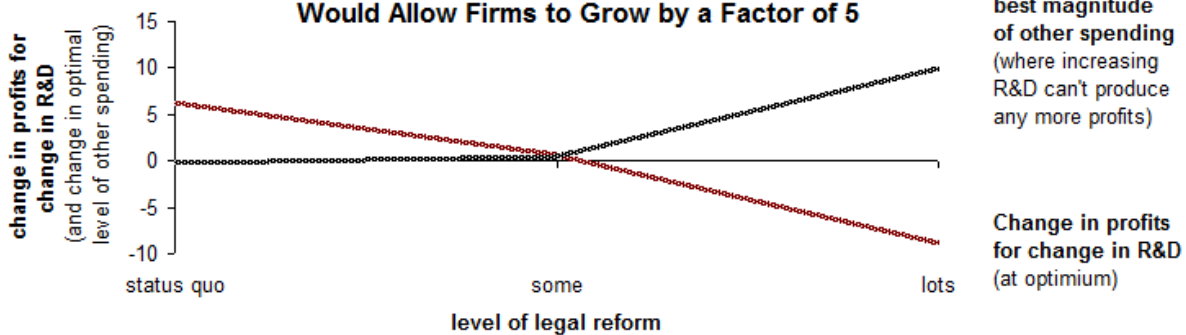
Figure 15: Equilibrium Profits Change Quickly As Other Expenses Change Due to the Feedback between Cash, R&D and Profits



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 16 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 16: Structural Reform of Qianhai's Innovation System Would Allow Firms to Grow by a Factor of 5



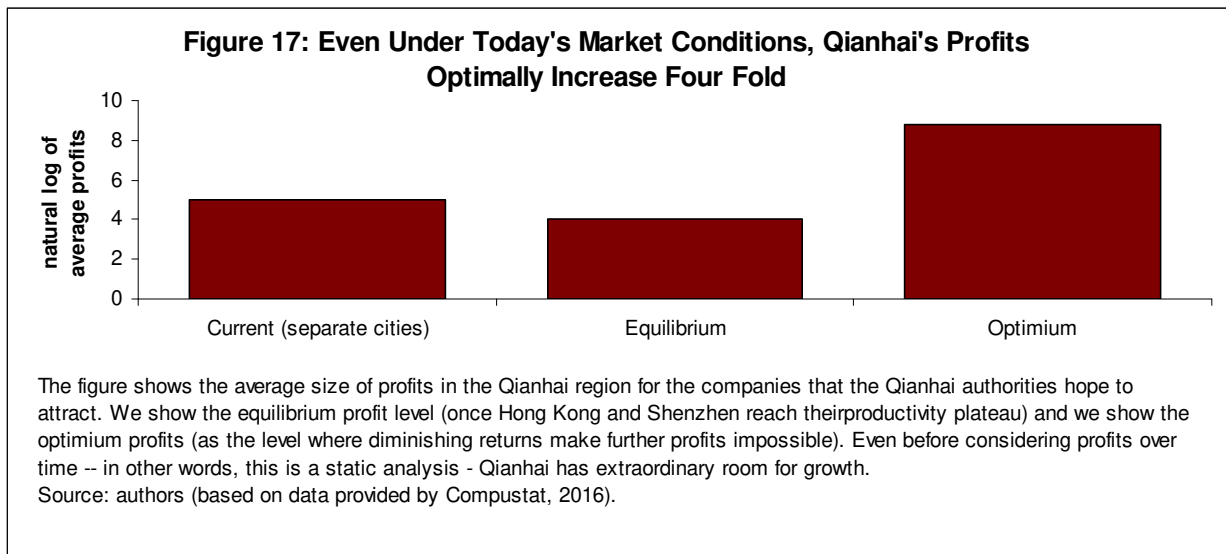
The figure shows that best in *O* with lots of reform is roughly five magnitudes higher -- this means that that the firm size where R&D cant produce more profits is five orders of magnitude larger.
Source: authors.

$$\frac{d\Pi^*}{dX} = Q + \frac{-(ad+e)g^2 + (1-cd)g}{(f+b)} \ln^{-1} O \ln O \left| \frac{d\ln O}{dX} \right| = \frac{(ad+e)g^2 - (1-cd)g}{(f+b)Q}$$

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

Optimal Profits and the Costs/Benefits of a Qianhai Authority

The market structure for innovative companies' prevents them from achieving their optimal profitability. Figure 17 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.³⁶ Similar to the previous calculations we showed, the Qianhai Authority has the opportunity to raise profits four fold in the Qianhai region.

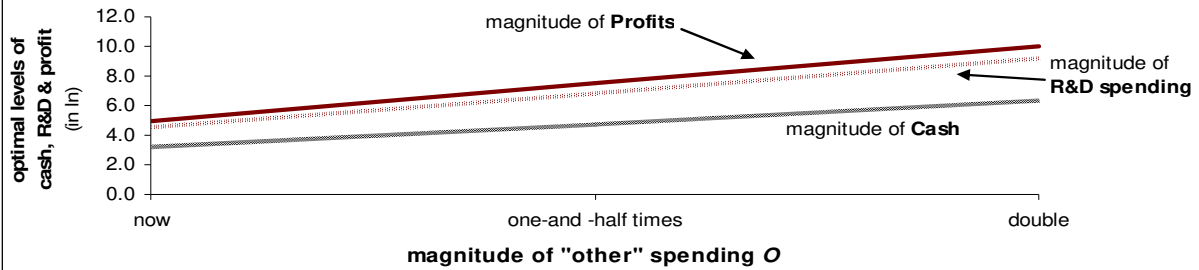


What effect can the legal reforms we propose have on innovation-led profits in the Qianhai region. Figures 18-20 show the way that authorities' actions – and “other” spending – affect optimal profits, R&D spending and cash-raising. In each case, optimal profits increase by around a factor of five(5).³⁷ 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.

³⁶ 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 α, β and γ . 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.

³⁷ 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.

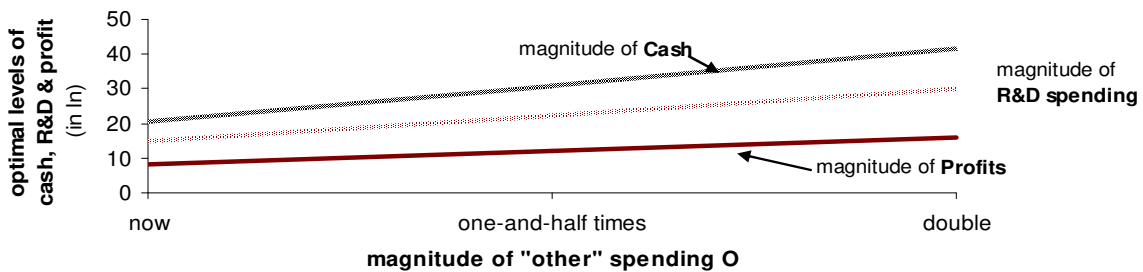
Figure 18: Optimal R&D Spending Much Higher than Equilibrium Level in Order to Maximise Innovation Sectors' Profits in the Qianhai Region



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 QJO in Which Qianhai Adopts NO Innovation Law Reforms

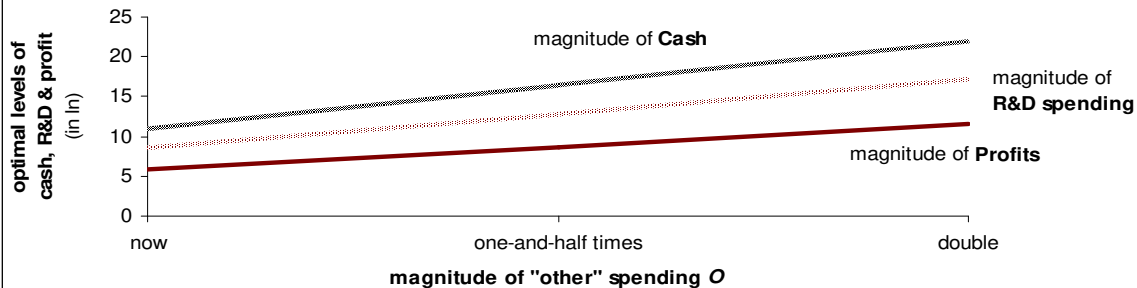
Figure 19: Limited Legal Reform Encourages Qianhai's Innovative Firms to Attract Investment Above All Else



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

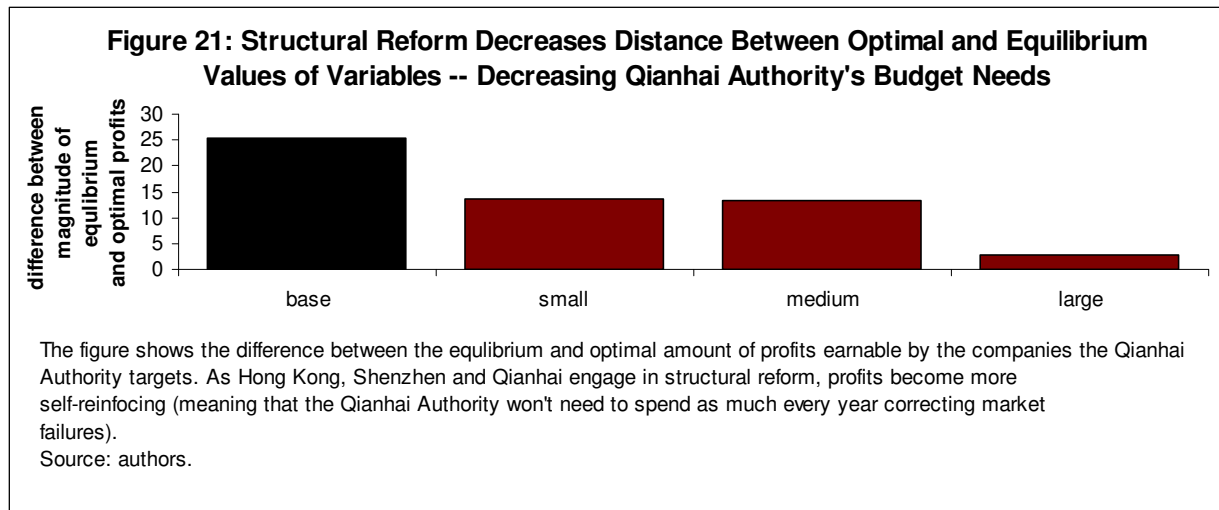
Figure 20: Extensive Legal Reform Makes Qianhai's Innovative Firms Small and Efficient Cash Seekers in a Larger Financial Centre



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 21 shows the difference between equilibrium and optimal profit levels over a range of reform “levels.”³⁸ 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).³⁹ More reform increases equilibrium levels of profit – bringing equilibrium levels of profits closer to their optimal levels.



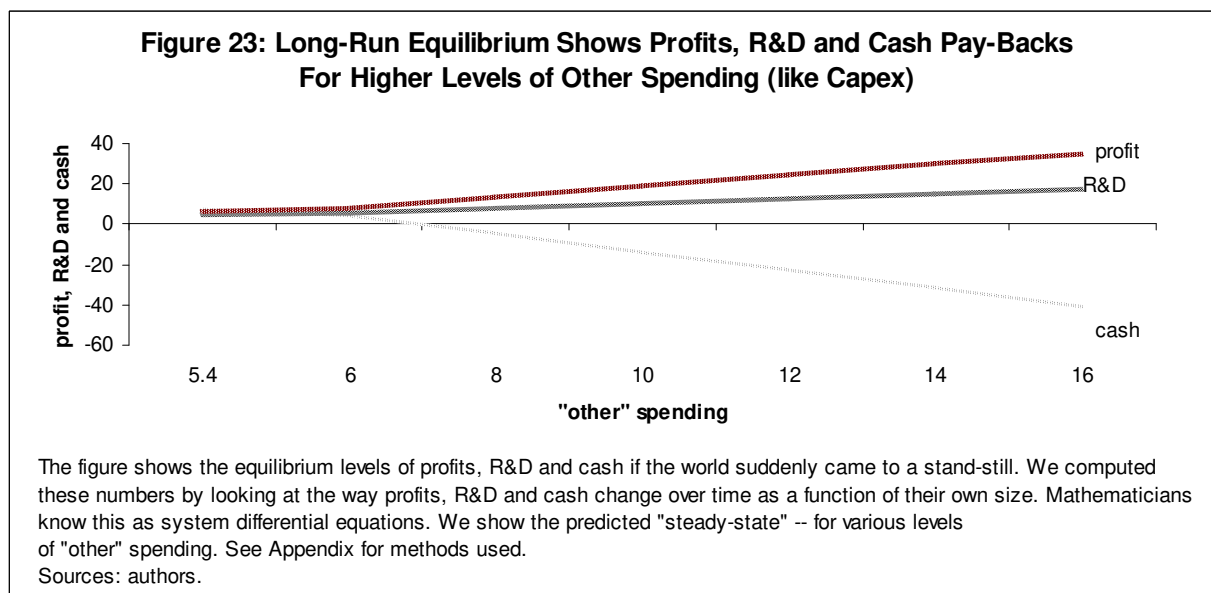
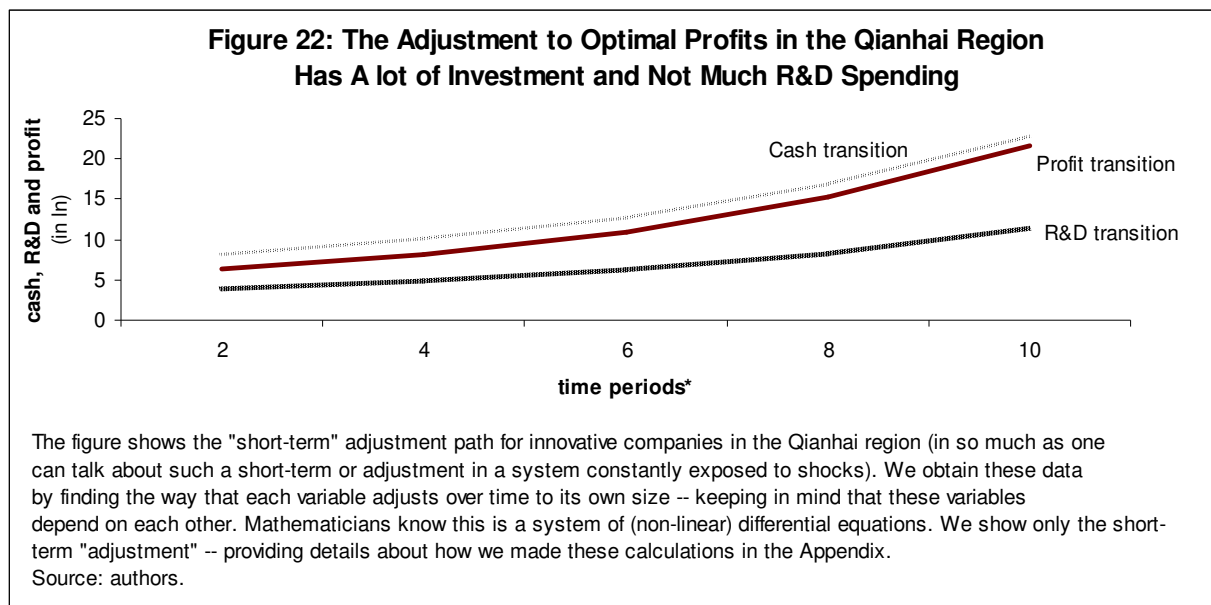
How Should the Qianhai Authority Plan its Reform Over the Next 5-10 years?

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 22 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

³⁸ 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.

³⁹ 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).

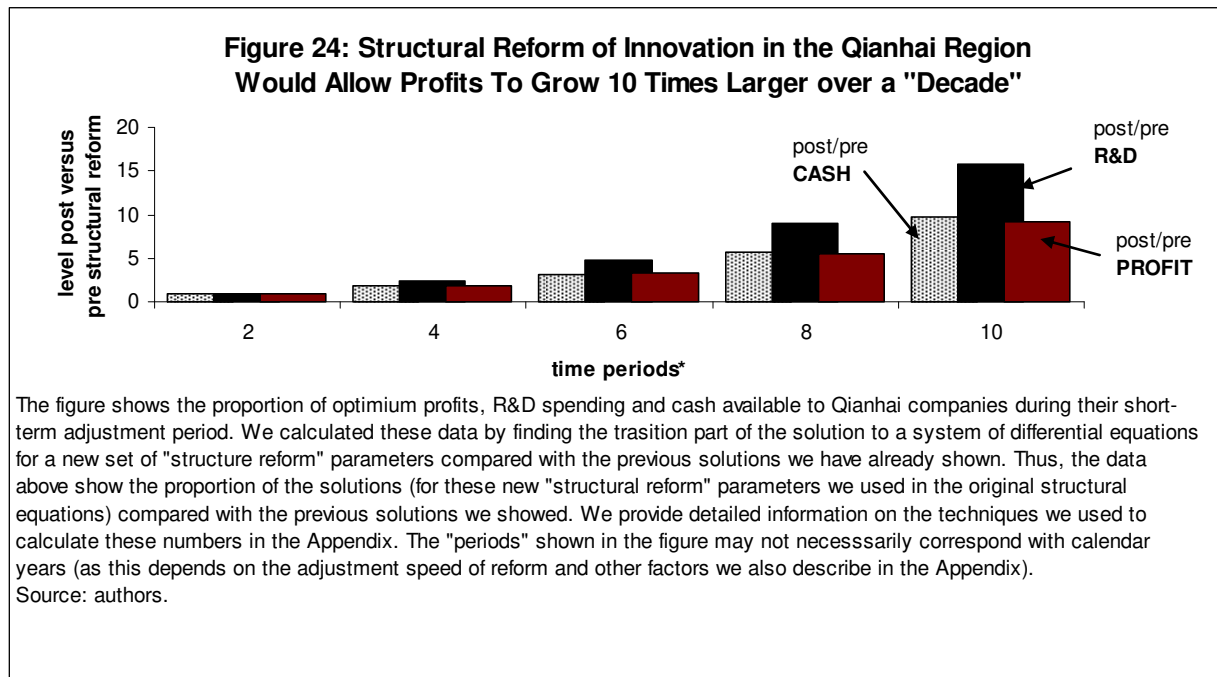
dynamic equilibrium level of cash falls as other spending eats up resources. We can find the difference between optimal and equilibrium profits, R&D spending and cash by simply comparing Figures 23 and 24. As such, a Qianhai Authority must adopt policies which make Qianhaiese firms increase “other” spending up to the point where the equilibrium profit level matches the optimal profit level.⁴⁰



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 25 shows the difference between cash, R&D spending and profits between the no-legal-reform case and the full

⁴⁰ 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.

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 factor of around 15 times above their level if no reform occurred.⁴¹ 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.



Conclusions

Qianhai – a (formerly) 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 Silicon 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?

Our paper uses structural equations modelling and method of moments estimation (and other types) to show how profits react to R&D and the availability of cash. We find that Qianhai has

⁴¹ 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 say that our model’s predictions will occur in calendar time.

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.

Our paper contributes to the wider literature in three ways. First, we look directly at profits - something few to no studies on innovation do well. In a capitalist system, profits drive resources, and thus innovation. Second, we walk the reader through the complex maths of economic change - using language which both policymaker and academic alike can appreciate. Our maths and statistics show us how legal/policy change happens because of an innovation centre/zone. Third, we provide estimates for the profitability of an international financial centre, under a set of reforms. Few studies have attempted such an undertaking.

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