Growth Diagnostics: A Foundation*

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Abstract

Growth diagnostics is an influential policy framework that, in second-best settings, has been used to identify the priorities of policy reform in different countries. With limited information about the nature of interaction between different second-best distortions, mistakes (situations where realized social welfare losses overwhelm any intended gains) could occur in the implementation of growth diagnostics. Even allowing for the possibility of mistakes, would an adaptive implementation of growth diagnostics converge to a socially optimal outcome? This paper sets out the conditions under which such convergence occurs. A number of different historical examples are discussed to illustrate how such a process could play out in practice.

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1 Introduction

Taking as its starting point the divergence between private and social valuations of economic activity, growth diagnostics (Hausmann, Rodrik, Velasco (2005), Hausmann, Klinger, Wagner (2008), Rodrik (2010)) is a strategy for identifying the priorities for policy reform in settings characterized by second-best distortions (Pigou (1954), Lispey (1956)). As Hausmann, Rodrik, Velasco (2005) put it: "The idea behind the strategy is simple: if (a) for whatever reason the full list of requisite reforms is unknowable or impractical, and (b) figuring out the second-best interactions across markets is a near-impossible task, the best approach is to focus on the reforms where the direct effects can be reasonably guessed to be large. ... The principle to follow is simple: go for the reforms that alleviate the most binding constraints, and hence produce the biggest bang for the reform buck."

A vast policy literature uses growth diagnostics as a policy framework, from the early work by the World Bank (World Bank (2005), with a focus on emerging market economies and eastern European Economies e.g. Cambodia, India, Brazil, the Baltic States) and the Asian Development Bank (Felipe et. al. (2011)), to the more recent initiative by the Scottish Government (Scottish Government (2016)) focusing on inclusive growth and the related work in New Zealand (Karacaoglu (2015)). The bulk of this literature uses growth diagnostics as a tool for identifying priorities for policy reform at a given point in time.

However, the empirical literature on policy reform and growth (e.g. Hausmann, Pritchett and Rodrik (2005)) suggests that policy reform is an adaptive process that occurs over a period of time; moreover, policy reforms that work in some settings do not necessarily work in all settings (Rodrik (2008)), conventional wisdom is often wrong (Campos and Coricelli (2002)), the sequencing of policy reform matters and policy-makers may get the sequencing wrong (Edwards (1990)).

Further, second-best distortions may interact in ways that mean the indirect social welfare losses of relaxing a second-best constraint swamp the direct social welfare gain from doing so (see Bergoeing, Loayza and Piguillem (2016) for an empirical analysis in the context of firm entry/exit and adoption of new technologies in emerging market economies). Reducing a distortion in one activity introduces distortions in activities that, before the policy reform, were otherwise undistorted e.g. mitigating the underprovision of a public good by a distortionary income tax. If the policy-maker wrongly estimates the benefits and costs involved, there may be an overall net social welfare loss.

Motivated by the preceding considerations, this paper provides a formal analysis of the conditions under which an adaptive implementation of growth diagnostics converges to a socially desirable growth outcome even allowing for the possibility of mistakes i.e. situations where the losses dominate the gains.

While the policy-maker may have a reasonably accurate estimate of the first-order approximation (direct effect) of reducing a distortion, information about the second-order effects of doing so is less reliable. Nevertheless, the policy-maker may have access to different sources of information (signals generated by an unknown stochastic process) that produce estimates of potential losses to social welfare from the second-order interaction effects. When these losses outweigh the first-order welfare gains, a mistake occurs.

We study an adaptive policy process, which, under minimal assumptions on the nature of uncertainty ensures (Proposition 1) that realized gross social welfare losses are almost surely (with probability one) bounded. This condition, in turn, implies convergence to the socially optimal outcome. The adaptive policy process ensures that the change in the weight assigned to different signals point in the same direction as net social welfare gains irrespective of the outcome, a property similar to one used in the proof of Blackwell's approachability theorem (Blackwell (1956)). Then, Proposition 2 shows that *any* policy process (and not just the one formally analysed below in section 3.2) which satisfies the condition that losses are almost surely bounded will converge to the socially optimal outcome.

How economic insights should be translated into governmental legislation is a long-standing debate. Lindblom (1959, 1979) was an early proponent of incremental experimentation in policy-making. He argued that any economic analysis comes with a high degree of uncertainty and must be regarded as incomplete. In a static policy-setting, he showed that reforms based on these analyses should reflect the underlying incompleteness by implementing changes in small steps and profiting from the information feedback rather than reaching for swiping "all-or-nothing" solutions. While Lindblom (1959,1979) saw *muddling* as the best of a number of bad options, scholars have since gone beyond these claims in examining the role of explicit and purposeful experimentation in policy-making (Hayek 1978; North 1990; Roland 2000; Mukand and Rodrik 2005). Our theoretical results contribute to this literature by showing how a process of policy making involving adaptive experimentation can, under minimal assumptions on the uncertainty involved, converge to the socially optimal outcome. In Section 4, we discuss a number of different historical examples to illustrate how such a process could play out in practice.

Our results are related to the convergence properties of iterative processes in public good and collective consumption by Dréze and de la Vallee Poussin (1971), Malinvaud (1972) and retrading in market games (Ghosal and Morelli (2004)) where reallocations can be Pareto improving at each step. However, in contrast to Proposition 2, these papers do not allow for the possibility of mistakes. Ghosal and Porter (2013) in their analysis of cautious retrading in the context of exchange economies assume a property related to the condition that losses are almost surely bounded; however, in contrast to Proposition 1, they do not derive it as an outcome of an explicitly defined adaptive forecasting and policy implementation process. The formulation the adaptive policy process and the first part of the proof of Proposition 1 is related to Cesa-Bianchi. and Lugosi (2004).

In specific settings, taking into account both the direct and indirect effects of policy reform that target second-best distortions is particularly important with limited fiscal resources, a point emphasized by Martin and Pindyk (2015) and in policy discussions by the New Zealand Government (Karacaoglu (2015), (2016)) and various Scottish Government papers linked to the use of growth diagnostics (e.g. Gillespie (2016), Scottish Government (2016)).

The remainder of the paper is structured as follows. Section 2 sets out a reduced form second-best policy framework; section 3 is devoted to stating and deriving the main results of the paper. Section 4 is devoted to a discussion of relevant historical examples. The last section concludes.

2 A Reduced-Form Policy Framework

We begin by setting out a reduced form policy framework that takes as the starting point the role of second-best distortions which introduce a wedge between social and private marginal valuations of economic activity.

Let $X = \{X_{i,a,t} : i \in I, a \in A, t \in T\}$ denote a trajectory where I denotes a list of activities, A denotes a list of economic agents and T (where T could be finite or infinite) denotes a list of time periods.

Let $\mathbf{X} \subset \Re^{IAT}$ denote the set of feasible trajectories. Feasibility, in this context, would include constraints such as intertemporal budget (resource) and technological constraints. We allow for the feasible state to depend on the initial state summarizing the history of the economy. We assume that $\mathbf{X}$ is a compact, convex set with a non-empty interior.

Let $W : \mathbf{X} \to R$ denote a continuous, strictly concave twice continuously (Frechet) differentiable social welfare function that has a unique maximum (denoted by Y) in the interior of $\mathbf{X}$.

Let $X \neq Y$ denote the equilibrium trajectory generated by some underlying pattern of market/strategic interactions between agents over time. As $X \neq Y$, it must be the case that there are distortions which introduce a wedge between social and private marginal valuations in economic activity. Let $u_a : \mathbf{X} \to R$ denote a continuous, concave, twice continuously (Frechet) differentiable utility function that represents the preferences of agent a over the set of feasible trajectories.

Let $u_{a,i,t}(X)$ denote the marginal valuation of activity i by agent a at period t. It follows that for at least one activity i and agent a, there exists a constant $d_{a,i,t} \neq 0$ such that

$$W_{i,t}(X) - u_{a,i,t}(X) - d_{a,i,t} = 0, i \in I, a \in A, t \in T \qquad (1)$$

where along trajectory X, $W_{i,t}(X)$ denotes the social valuation of activity i at time t, $u_{a,i,t}(X)$ denotes the corresponding private valuation by agent a and $d_{a,i,t} \neq 0$ for some $i \in I, a \in A, t \in T$ is the resulting distortion.

Consider, a second-best social welfare maximization where at a given point in time t, taking the trajectory X as a starting point, the social planner maximizes W over $\mathbf{X}$ treating (1) as a system of constraints. Let $d_t = (d_{a,i,t} : i \in I, a \in A)$. Let $\widetilde{W}(d_t)$ denote the value function of the maximization problem viewed as a function of d_t. Consider a vector of perturbations in a small neighbourhood of zero, $\varepsilon_t = (\varepsilon_{a,i,t} : i \in I, a \in A)$. Suppose the policy-maker attempts to alter the second-best distortions d_t by ε_t. Using a (second-order) Taylor series expansion, we obtain:

$$\begin{aligned}\Delta_{\varepsilon_t}(X; d_t) &= \widetilde{W}(d_t + \varepsilon_t) - \widetilde{W}(d_t) \\ &= \sum_{a,i} \varepsilon_{a,i,t} \frac{\partial \widetilde{W}(d_t)}{\partial d_{a,i,t}} + \frac{1}{2} \sum_{a,i} \sum_{a',i'} \varepsilon_{a,i,t} \varepsilon_{a',i',t} \frac{\partial^2 \widetilde{W}(d_t)}{\partial d_{a',i',t} \partial d_{a,i,t}} \qquad (2)\end{aligned}$$

For each $a \in A$, and $i \in I$ and $t \in T$, let $\mu_{a,i,t}$ denote the Lagrangian multiplier associated with (1) in the maximization problem where taking the trajectory X as a starting point, the social planner maximizes W over $\mathbf{X}$ treating (1) as a system of constraints. Clearly $\mu_{a,i,t}$ can be interpreted as the marginal (incremental) social value along the trajectory X of reducing the distortion of activity i for agent a at time t. As $\widetilde{W}_t(d_t)$ is a value function, using duality, it follows that:

$$\frac{\partial \widetilde{W}_t\left(d_t\right)}{\partial d_{a,i,t}} = -\mu_{a,i,t} \text{ for all } a, i, t \text{ such that } d_{a,i,t} \neq 0 \text{ (3).}$$

The first term in equation (2) captures the *direct effect* on social welfare, at a given point of time, when distortion of activity i' for agent a' at time t' is reduced. Using equation (3), it is clear that when activity i is undistorted so that $d_{a,i,t} = 0$, the social valuation and private valuation of activity i at time t are identical. Along a specific trajectory X, the more socially costly is the distortion in activity i for agent a at time t, the higher is the value of $\mu_{a,i,t}$, the current marginal social valuation of reducing the distortion $d_{a,i,t}$.

The second term in equation (2) captures the *indirect effect* on social welfare of reducing the distortion $d_{a,i,t}$ via its impact on the marginal social valuation of reducing the distortion valuation $d_{a',i',t}$: when there are other distorted activities, on the margin, the interaction effects between the different distortions will matter. The sum of the second-order indirect effects captures the effect of changing the distortion in activity i' for agent a' at time t' on the marginal social value of reducing distortions in all other activities i for other agents a.

Once indirect effects are taken into account, a reduction in the distortion in activity i by agent a at time t, unless it is "local" (i.e. without an economy-wide consequence) could even produce an overall social welfare loss, a potential second-best complication. This point is important when policy reform cannot target a second-best distortion on a specific economic activity (e.g. emissions reduction or remedying the underprovision of a public good by a distortionary tax on effort) by an individual agent without simultaneously targeting the distortions in that same activity for other agents.

3 Adaptation, Mistakes and Convergence to Social Optimum

Heuristically, growth diagnostics can be viewed as an adaptive strategy for identifying the priorities for policy reform. In this section, we model growth diagnostics as an adaptive policy tool i.e. at each point in time, given the prevailing trajectory of the economy, reduce the second-best distortion or gap with the greatest direct social impact. However, in attempting to do so, the policy maker may not have enough information to rule out losses in social welfare from an application of the growth diagnostic. What are there conditions under which an adaptive application of growth diagnostics results in a sequence of changes in social welfare that converge to the socially optimal outcome even allowing for the possibility of mistakes? In this section, model an adaptive forecasting and policy implementation process, which under minimal assumptions on the nature of uncertainty over potential welfare losses, converges to the socially optimal allocation.

Starting from some feasible trajectory $X \neq Y$, at a given t and the associated vector of distortions d_t, the policy-maker implements $d_t + \varepsilon_t$, where $\varepsilon_t = \arg\max_{\varepsilon_t \in N(0)} \Delta_{\varepsilon_t}(X; d_t)$ (where $N(0)$ is in a small neighbourhood of zero) with the objective of achieving gross social welfare gains $\Delta(X; d_t)$ (upto a second-order approximation). For later reference, we label this as **implementing growth diagnostics** at time t.

Starting at some initial time period $t = 0$, an **adaptive implementation of growth diagnostics** generates a sequence of trajectories $\left(\widehat{X}(t) : t \geq 0\right)$ and an associated sequence of (potential) gross social welfare gains $\left(\Delta\left(\widehat{X}(t); d_t\right) : t \geq 1\right)$.

Starting from some trajectory X at time t, let $l_t \geq 0$ denote the gross social welfare loss incurred after implementing $d_t + \varepsilon_t$ so that net social welfare is $\Delta(X; d_t) - l_t$ (upto a second-order approximation) at time t. We say that the policy maker makes a **mistake** while implementing the growth diagnostics whenever $\Delta(X) - l_t < 0$ i.e. there is a net social welfare loss at time t.

We assume that $l_t \leq \tilde{L}$, $\widetilde{L} > 0$ at each t where the bound $\tilde{L}$ on the gross social welfare loss in any one period is uniform over $\mathbf{X}$. Furthermore, assume that there are $s = 1, ..., N$ sources of signals about the gross social welfare loss $l_{s,t} \leq \widetilde{L}$ that could be incurred when growth diagnostics is implemented at time t. For each signal $s = 1, ..., N$, the policy-maker computes the net social welfare $\Delta(X(0)) - l_{s,0}$.

Assume that the policy maker puts a weight $f_{s,0} = 1$ on each signal s. Let $f_{s,t}$ denote the weight on signal s at some $t \geq 0$. Given α, $\frac{1}{2} \leq \alpha < 1$, if there are at least as many signals as αN such that $\Delta(X(0)) - l_{s,0} \geq 0$ (a net social welfare gain), growth diagnostics is implemented at $t = 0$; otherwise, the policy maker does nothing and the economies continues along $X(0)$ for one more time period.

If a mistake occurs (i.e. there is an actual net social welfare loss) the policy-maker reduces the weight on all signals s such that $\Delta(X(0)) - l_{s,0} \geq 0$ by a fixed fraction β, $0 < \beta < 1$.

In any subsequent period $t > 0$, the policy maker compares the total weight of the experts that recommend predicting a net social welfare gain with those predicting a net social welfare loss at $X(t)$ and growth diagnostics is implemented only if the total weight on signals predicting a net social welfare gain exceeds αF_t, where F_t is the total weight on signals in period t; otherwise, the policy maker does nothing and the economy continues along $X(t)$ for one more time period.

As before, at each t where a mistake occurs the policy-maker reduces the weight on all signals s such that $\Delta(X(t)) - l_{s,t} \geq 0$ by a fixed fraction β, $0 < \beta < 1$.

We make one assumption about the underlying stochastic processes generating the signals, **the almost surely finite mistakes property**: there exists a signal s^* (the policy-maker does not know which one) such that, with probability one, along the sequence of trajectories $\{X(t) : t \geq 0\}$ generated by an adaptive implementation of growth diagnostics, the corresponding sequence $\{l_t : t \geq 0\}$ is such that $\Delta(X(t)) - l_{s^*,t} < 0$ only for finitely many t, $t \geq 0$: this number (assumed to be the minimum over all signals which satisfy the above property) is denoted by m^*.

We make no other assumptions about the underlying stochastic processes generating the signals, specifically, we do not assume that the policy maker knows that the underlying stochastic processes generating the signals has the almost surely finite mistakes property.

Note that, by construction, the adaptive forecasting and policy making process satisfies the following condition for each $t \geq 0$:

$$\sum_s [\Delta(X(t)) - l_{s,t}] [f_{s,t+1} - f_{s,t}] \geq 0 \ (4)$$

In words, the change in the weight assigned to different signals point in the same direction as net social welfare gains, irrespective of the outcome. This condition is similar to a key property used in the proof of Blackwell's approachability theorem (Blackwell (1956)).

Let $l_t \in \{l_{s,t} : s = 1, ..., N\}$ denote the realised gross social welfare loss incurred at time t when growth diagnostics is implemented at time t. We say that **losses are almost surely bounded** if $\sum_{t=0}^{\infty} l_t \leq L$, for some finite L, with probability one.

We are now in a position to state the following result which clarifies the conditions under which losses are almost surely bounded even allowing for the possibility of mistakes:

Proposition 1: *Consider the adaptive policy process described above. Then, losses are almost surely bounded.*

Proof. Starting from some trajectory $X \neq Y$, at each $t \geq 0$, there are two possibilities: (1) the total weight on signals predicting a net social welfare gain exceeds αF_t, and (2) the total weight on signals predicting a net social welfare gain is strictly less than αF_t. At t, a mistake is only possible if (1) prevails.

Let F_m denote the total weight on signals when the policy-maker makes the m-th mistake. At the time period when the policy maker makes the m-th mistake, the overall weight of the signals forecasting a net social welfare gain must be at least αF_m; the weight on the signals forecasting a net social welfare loss is unchanged at $(1 - \alpha)\beta F_{m-1}$.

By computation it follows that

$$\begin{aligned} F_m &\leq (1 - \alpha)\beta F_{m-1} + \alpha F_{m-1} \\ &= F_{m-1}\left((1 - \alpha)\beta + \alpha\right). \end{aligned}$$

Moreover, $F_m \geq \beta^{m^*}$ as the current weight on signal s^*, $f_{s^*,t}$, must be such that $f_{s^*,t} \geq \beta^{m^*}$ (given that $0 < \beta < 1$) and $F_m \geq f_{s^*,t}$. Therefore, it must be the case that

$$\beta^{m^*} \leq F_{m-1}\left((1 - \alpha)\beta + \alpha\right)$$

from which it follows that

$$\beta^{m^*} \leq F_0\left((1 - \alpha)\beta + \alpha\right)^m$$

which, by computation, is equivalent to

$$\left(\frac{1}{(1 - \alpha)\beta + \alpha}\right)^m \leq N\left(\frac{1}{\beta}\right)^{m^*}.$$

Furthermore,

$$m \ln \left(\frac{1}{(1-\alpha)\beta + \alpha} \right) \leq \ln N + m^* \ln \left(\frac{1}{\beta} \right)$$

which, by computation, is equivalent to

$$m \leq m_{\max} = \frac{\ln N + m^* \ln \left(\frac{1}{\beta} \right)}{\ln \left(\frac{1}{(1-\alpha)\beta+\alpha} \right)}$$

as $(1-\alpha)\beta + \alpha < 1$.

Therefore, along the sequence generated by the adaptive policy process, with probability one, there is at most a finite number of mistakes and the sum over gross realised social welfare losses across all the time periods in which mistakes are made is bounded above by $m_{\max}\widetilde{L}$.

When a mistake *does not* occur at time t, we have that $\Delta(X(t)) - l_t \geq 0$. Now, along the sequence generated by the adaptive forecasting and policy implementation process, it must be the case that $\lim_{t\to\infty} \Delta(X(t)) = 0$ (as the total social welfare gains is bounded which follows from the assumption that W is a continuous function over a compact set).

It follows that with probability one, $\lim_{t\to\infty} l_t = 0$. Therefore, $\sum_{t=0}^{\infty} l_t \leq \widehat{L}$, for some finite $\widehat{L}$, with probability one, across all the time periods when no mistake occurs.

Set $L = m_{\max}\widetilde{L} + \widehat{L}$. Then, gross social welfare losses are almost surely bounded by L. ■

The next proposition demonstrates that *any* process which satisfies the condition that losses are almost surely bounded will converge to the socially optimal outcome:

Proposition 2: *When losses are almost surely bounded, starting from a socially suboptimal trajectory X, the adaptive forecasting and policy implementation process leads to the socially optimal trajectory Y.*

Proof. Let $X(t)$ be the current trajectory picked by the iterated application of growth diagnostics and let W_t be the associated level of social welfare. Let l_t be the social welfare loss incurred in period t, where if no social welfare loss occurs in period t then $l_t = 0$).

By assumption the total social welfare loss is almost surely bounded. Let the sequence V_t, indexed by t, be given by $V_t = W_t + \sum_{k=0}^{t} l_k$. Then this new sequence V_t is increasing. It is also bounded as it is the sum of two bounded sequences. Therefore it converges to a limit, say $\widehat{V}$. But this implies that W_t also converges to some limit $\widehat{W}$.

Let the associated sequence of trajectories be labelled as $\left(\widehat{X}(t) : t \geq 0\right)$ and let $\widehat{Y}$ denote any limit point of the sequence with $W(\widehat{Y}) = \widehat{W}$.

Under the assumption of almost surely bounded losses, there is a subsequence (with a slight abuse of notation, denoted in the same way as the original sequence) $\left(\widehat{X}(t) : t \geq 0\right)$ such that both $\lim_{t\to\infty} l_t = 0$ and $\lim_{t\to\infty} \Delta\left(\widehat{X}(t); d_t\right) = 0$.

Suppose, by contradiction, $W(\widehat{Y}) < W(Y)$. Then, starting from $\widehat{Y}$, it follows that $\Delta\left(\widehat{Y}; d_t\right) > 0$ at each $t \in T$. By continuity of W, there exists a T' such that for all $t > T'$, $\Delta\left(\widehat{X}(t); d_t\right) > 0$.

As losses are almost surely bounded, it follows that there exists T'' such that for all $t > T''$, $\Delta\left(\widehat{X}(t)\right) - l_t > 0$. But, then, $\widehat{Y}$ cannot be a limit point, a contradiction.

Therefore, $W(\widehat{Y}) = W(Y)$ and by continuity of $W(.)$ over $\mathbf{X}$, $W(\widehat{Y}) = \overline{W}$ and by the strict concavity of W, $\widehat{Y} = Y$. ■

4 Discussion

The fundamental insight form the theoretical analysis is that an adaptive forecasting and policy-making process where small adjustments are made in the direction of potential welfare gains will over time converge to a socially optimal outcome even allowing for the possibility of making mistakes. In this section, we illustrate how such a process could play out in practice with reference to a number of actual historical examples.

The potential benefits of incremental, adaptive policy experimentation, as well as the dangers of not doing so, are well exemplified by the economic history of China. In 1958, the communist government launched the Great Leap Forward movement. Its goal was to boost the country's industrial production. Ambitions for the project went as high as surpassing the United Kingdom in terms of raw output within 15 years. In order to achieve these dramatic results, resources, in the form of labour reallocation and increased direct taxation, were diverted from the Chinese agriculture (among other sectors).

In the short-run, the reform successfully achieved some its intended direct effects by raising the steel output from 5.35 million tons in 1957 to 18.66 million tons in 1960. (Chan, 2001) However, the estimated capabilities of the agricultural sector to cope with increased quotas with fewer dedicated inputs turned out horrendously false.

The outcome was a disaster. Li and Yang (2005) provide a detailed analysis of the events. China's food production collapsed, with grain output falling by about 15% in each of the years 1959-1961. Even by the most conservative estimates, the resulting famine claimed the highest number of lives in recorded world history. The country's gross domestic product stagnated in 1960 and then fell by 16% and 5.6% in 1961 and 1962, respectively the two worst performances from 1952 until today (data from National Bureau of Statistics of China, 2017). Li and Yang (2005) show that the communist party's proclaimed explanation of bad weather as the main cause of the events accounts for only 13% of food shortages. They found that over 60% of the decline in grain production, and thus the ensuing humanitarian and economic crisis, was attributable to errors in decision-making of the government.[1]

The development strategy of the economically highly successful post-Mao era contrasted starkly from its precursor. Deng Xiaoping famously coined the Chinese style of policy-making of the time as "crossing the river by feeling the stones"- a gradual, adaptive and directed progression that preceded each step in reforming by careful testing. This approach was in part necessitated by the lack of the ruling elite of an exact and comprehensive blueprint for China's future (Lin et. al (2003), Naughton (2006)). But rather than forcing the intended changes through the political opposition, the adaptive reform implementation took the existing uncertainties deliberately into account. In fact, Heilmann (2008a, 2008b) gives policy experimentation a front-row seat in China's economic miracle.

Many times over, momentous and potentially risky policy changes in China's transformation process were first tried out and studied on isolated parts of the economy before they were scaled-up. Long before China joined the World Trade Organisation and committed to today's level of openness to foreign enterprises, the government piloted special economic zones: geographically clearly defined areas in which the effects of internationalisation on the local economies could be observed and evaluated. The transition from a planning econ-

[1] Another example is the desiccation of the Aral Sea under the rule of the former Soviet Union. Starting in the 1940s, the water inflows of the then fourth largest lake in the world were diverted for irrigation in order to foster agricultural production in the surrounding desert environment. While the project achieved the desired direct effects by temporarily making Uzbekistan the largest exporter of cotton in 1980 (National Cotton Council of America, 2017)), the environmental and economic repercussions were vastly underestimated. By 1988, the continued shrinking of the lake and its increasing salination already caused losses of billions of rubles by entirely wiping out the area's fishing industry, damaging other branches and causing serious health problems in the population (Micklin, 1988). By 2007, the lake's surface area had shrunk to 10% of its original surface area with recent counter-measures only slowly reversing the trend (Micklin and Aladin, 2008).

omy with centrally fixed prices to a market economy was mediated via a dual-price system: quotas had to be delivered at plan-prices while any surplus could be sold for private profits by the producers.

More recently, China continues to pursue the internationalisation of its currency, the Renminbi, in a similar fashion. In 2004, the government showed first signs of its intentions by allowing Hong Kong based banks to open Renminbi accounts with limited conversion allowances. In 2009, the Renminbi was legitimised to settle trade with ASEAN members as well as Macao and Hong Kong in five Chinese cities. Upon satisfactory results, the scheme was first extended in mid-2010 so that firms in twenty provinces could settle all trade in the local currency. Nowadays essentially all trade settlements may be executed with it. (Eichengreen and Kawai, 2015)

While the economic history of China tells a compelling story of the dangers of "Big-Bang reformism" and the potential benefits of deliberate experimentation, both instances are by no means purely Chinese phenomena. Mukand and Rodrik (2005) note that while most Latin American countries vigorously underwent structural reforms, the national governments forced the commonly agreed best practices at the time upon the national economies with little care given to local needs. As a result, nearly all those countries achieved slower growth rates after the reforms than before.

A growing number of governments around the world reflect the lessons learned from history by harnessing the power of adaptive, policy-experimentation. The United Kingdom is at the forefront of the movement. Jowell (2003) summarises the already extensive role of pilot-studies in the UK's policy-making in the early 2000s. The national trend lately cumulated into the formation of the What Works Network with a total of nine institutions devoted to supplement political decision-makers with field evidence at crucial stages of reform design.

Finally, List and Gneezy (2014) cite the example of the movie delivery platform Netflix to argue for policy-experimentation not only on the side of national governments, but also as the cutting-edge in business managements. In 2011, the management of the then rising star in the market made a series of unfortunate decisions which resulted in falling customer subscriptions and subsequently plummeting stocks that brought the firm to the brink of bankruptcy. Today, literally every product change at the company is first tried out on an isolated cell of the consumer base. As the reason for their strategy the company state that such interventions are simply "too risky to roll out without extensive (...) testing." (Netflix Techblog, 2016)

5 Conclusions

In this paper, we view growth diagnostics as an iterative tool for identifying the priorities of policy reform: at each point in time, reduce the section-best distortion or gap with the greatest direct social impact. We show that such a process converges to the socially optimal allocation even if the policy-maker incurs unintended social welfare losses.

The formal analysis reported here provides a set of convergence results that demonstrate that growth diagnostics is a robust, flexible policy framework. However, in practice, policy reform is constrained by political interests. The results we obtain here constitute a starting point for an analysis that take such political constraints explicitly into account.

In future work, we plan to extend the analysis reported here to examine how special interest groups can attempt to influence which second-best distortions are addressed and the impact such influence can have on probability of making mistakes.

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