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Well-intended policies ☆

Francisco J. Buera [a,b], Benjamin Moll [c], Yongseok Shin [d,e,b,*]

[a] University of California at Los Angeles, United States
[b] NBER, United States
[c] Princeton University, United States
[d] Washington University in St. Louis, United States
[e] Federal Reserve Bank of St. Louis, United States

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ABSTRACT

Market failures provide a rationale for policy intervention. But policies are often hard to alter once in place. We argue that this inertia can result in well-intended policies having sizable negative long-run effects on aggregate output and productivity. In our theory, financial frictions provide a rationale for providing subsidized credit to productive entrepreneurs to alleviate the credit constraints they face. In the short run, such targeted subsidies have the intended effect and raise aggregate output and productivity. In the long run, however, individual productivities mean-revert while individual-specific subsidies remain fixed. As a result, entry into entrepreneurship is distorted: The subsidies prop up entrepreneurs that were formerly productive but are now unproductive, while impeding the entry of newly productive individuals. Therefore aggregate output and productivity are depressed. Our theory provides an explanation for two empirical observations on developing countries: idiosyncratic distortions that disproportionately affect productive establishments, and temporary growth miracles followed by growth failures.

The better is the enemy of the good. (Voltaire, *La Bégueule*, 1772)

Nothing is so permanent as a temporary government program. (Milton Friedman)

1. Introduction

A recent literature has stressed the quantitative importance of resource misallocation across heterogeneous producers for explaining the large differences in total factor productivity (TFP) across countries (Restuccia and Rogerson, 2008; Hsieh and Klenow, 2009). This literature models the misallocation in a reduced-form fashion with abstract taxes and subsidies, and is silent about the origins of these distortions.

In this paper, we present a theory of idiosyncratic distortions that originate from policies that are well-intended but hard to alter once in place. In doing so, we provide a cautionary tale about the unintended consequences of industrial policies, which can also explain why many developing countries experience temporary growth miracles and failures (Easterly et al., 1993; Jones and Olken, 2008). Even when industrial policies can foster development by remedying market failures (List,

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* Corresponding author at: Washington University in St. Louis, United States.
E-mail addresses: fjbuera@econ.ucla.edu (F.J. Buera), moll@princeton.edu (B. Moll), yshin@wustl.edu (Y. Shin).

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1885; Rodrik, 2008; Lin and Monga, 2010), they may deter long-run growth if governments are not able to adjust these policies over time.

The prime examples are found in Japan (Johnson, 1982; Doi and Hoshi, 2003) and Korea (Kim and Leipziger, 1997; Hong, 2002) in the 1980s and the 1990s.[1] In both countries, the governments successfully orchestrated industrial policies that resulted in rapid economic growth in the 1960s and the 1970s. The governments overtly promoted and subsidized productive large conglomerates, which were the engines of the growth spurt in these decades. However, even after many of the conglomerates had lost their productivity edges in the ensuing decades, they continued to receive favorable treatments and maintained a disproportionate presence that was not warranted by their productivity levels.[2] In measurement exercises, these would show up as rampant idiosyncratic distortions. In our view, such distortions are the unpleasant legacy of past industrial policies that may once have engineered economic growth.

This argument is relatively general and can be made in the context of a number of different industrial policies. However, for the sake of concreteness, we here focus on one particular policy: subsidized credit as a remedy against credit market imperfections, which has played an important role in practice (McKinnon, 1981; Diaz-Alejandro, 1985; Leipziger, 1997).

Our theory has three main elements. First, producers are heterogeneous in productivity, and individual productivity follows a mean-reverting stochastic process. Second, producers face limited-commitment constraints on credit. While the credit constraints themselves generate misallocation, this direct source of misallocation is not what we focus on. The credit constraints provide a rationale for well-meaning policymakers to provide subsidized credit to productive entrepreneurs. Finally, we assume that policies exhibit inertia. Credit subsidies are chosen in the first period and are fixed for each producer thereafter, while the subsidies are financed by taxing those producers that do not receive a subsidy.

We build a theoretical model with these assumptions, and then numerically analyze the impact of industrial policies using a calibrated version of it.

In our model, credit subsidies naturally relax the financial constraints faced by the recipients of the subsidy. Policymakers therefore choose to provide such subsidized credit to productive entrepreneurs. In the short run, this policy reallocates capital from unproductive towards productive entrepreneurs, and boosts per-capita income, TFP, and capital accumulation.

Over time, as the productivities of entrepreneurs revert to the mean, subsidized individuals are not necessarily the most productive entrepreneurs, while newly productive entrepreneurs have to pay the taxes that finance the credit subsidies. Therefore, in the long run, the initial policy results in idiosyncratic taxes and subsidies that contribute to the misallocation of resources from productive entrepreneurs towards unproductive ones who stay in business only because they are subsidized. Because of mean-reversion, in the stationary equilibrium, taxes and subsidies are uncorrelated with the productivities of the overall population. However, credit subsidies are *negatively* correlated with the productivity of individuals who choose to be active entrepreneurs, because of distorted entry decisions. Similarly, taxes are *positively* correlated with the productivities of active entrepreneurs.[3]

Our theory provides a rationale for two distinct features of developing countries. First, we rationalize, with well-intended policies, the existence of idiosyncratic distortions that affect productive entrepreneurs disproportionately more (Restuccia and Rogerson, 2008): Idiosyncratic distortions are the legacy of well-intended industrial policies. Second, our model can account for the fact that many developing countries experience temporary growth miracles and failures at a frequency of about ten years (Easterly et al., 1993; Jones and Olken, 2008). This fact holds for all but the very richest countries and the few persistent growth miracles. Indeed, for a large fraction of countries, decades of fast growth are followed by failures, consistent with our theory.[4]

The next section develops our theory. We calibrate the theoretical model in Section 3, and numerically analyze the impact of industrial policies in Section 4. In Section 5, we consider alternative policy experiments. Section 6 concludes the paper.

[1] To be clear, we are thinking of industrial policies that successfully promoted economic growth at least initially but left negative consequences eventually. Many other countries have engaged in systematic industrial policies. Most of them adopted import-substitution policies, which left equally negative long-term consequences without clear short-term benefits measured by economic growth. The experiences of several Latin American countries fit this description, as documented by Cole et al. (2005) and the references therein.

[2] Such persistence does not necessarily presuppose the unadjusted continuation of government policies per se. In both Japan and Korea, the subsidies to the conglomerates were often in the form of government-directed loans from banks. Even after the overt government subsidies had been annulled, banks continued to provide cheap credit to many unproductive, now-insolvent conglomerates, because a recognition of the bad debt would have bankrupted the banks themselves (Hoshi, 2000). This practice is also known as "evergreening" or, with less euphemism, "zombie lending." Our theory abstracts from this mechanism, and simply assumes that the policies favoring certain firms continue on, regardless of their future productivity or profitability.

[3] While we assume that entrepreneurial productivity follows an exogenous mean-reverting stochastic process to obtain the eventual negative correlation between subsidies and the productivity of active entrepreneurs, there is an alternative: As in many popular narratives—for example, Chu (2000)—subsidies partly shield the recipients from competitive pressure and may result in suboptimal investment in technological and managerial innovations, ultimately leading to lower productivity. This is another way in which industrial policies adversely affect the long-run macroeconomic performance. Although this argument is persuasive, we abstract from such considerations and leave them for future research.

[4] It is not our contention that credit subsidies, let alone broader industrial policies, always have positive effects in the short run and negative effects in the long run. Drastically more negative consequences are associated with government efforts to mobilize domestic savings to promote rapid industrialization processes in the underdeveloped world, especially Latin America, which oftentimes led to financial repression (Diaz-Alejandro, 1985).

2. Model

In this section, we introduce the basic model with which we evaluate the aggregate and distributional impact of industrial policies that are implemented through taxes and subsidies.

There is a unit measure of infinitely-lived individuals, who are heterogeneous in their wealth and the quality of their entrepreneurial idea or talent, z. Their wealth is determined endogenously by forward-looking saving behavior. The entrepreneurial ideas follow a stochastic process.

In each period, individuals choose their occupation: whether to work for a wage or to operate a business (entrepreneurship). Their occupational choices are based on their comparative advantage as an entrepreneur z and their access to capital, as well as the taxes and subsidies they face. We assume imperfect enforceability of capital rental contracts, which leads to an endogenous collateral constraint through which access to capital is influenced by wealth.

One entrepreneur can operate only one production unit (establishment) in a given period. Entrepreneurial ideas are inalienable, and there is no market for managers or entrepreneurial talent.

2.1. Preferences and technology

Individual preferences are described by the following expected utility function over sequences of consumption c_t:

$$U(c) = \mathbb{E}_0\left[\sum_{t=0}^{\infty} \beta^t u(c_t)\right], \quad u(c_t) = \frac{c_t^{1-\sigma}}{1-\sigma}, \tag{1}$$

where β is the discount factor, and σ is the coefficient of relative risk aversion.

An entrepreneur with talent z produces using capital k and labor l according to:

$$zf(k,l) = zk^{\alpha} l^{\theta},$$

where α and θ are the elasticities of output with respect to capital and labor, and $\alpha + \theta < 1$, implying diminishing returns to scale in variable factors at the establishment level.

We assume that entrepreneurial ideas are drawn from a Pareto distribution with tail parameter η. To be more specific, the probability density function is $\mu(z) = \eta z^{-\eta-1}$ for $z \geqslant 1$. Entrepreneurial ideas "die" with a constant hazard rate of $1-\gamma$, in which case a new idea is drawn from $\mu(z)$ independently of the quality of the previous idea; that is, γ controls the persistence of the entrepreneurial idea or talent process. The γ shock can be interpreted as changes in market conditions that affect the profitability of individual skills or business opportunities.

2.2. Taxes and subsidies

The government may set individual-specific taxes and subsidies. Following Restuccia and Rogerson (2008), we assume that the taxes are levied on the revenue of an entrepreneur, denoted by $\tau_i \geqslant 0$. Motivated by the fact that subsidized credit is an important element of real-world industrial policies (McKinnon, 1981; Diaz-Alejandro, 1985; Leipziger, 1997), we assume that the government grants selected entrepreneurs access to a given size of capital rental at no cost. The maximum amount of subsidized capital for an individual i is denoted by κ_i. Below, in Section 2.3, we show how this guaranteed free capital from the government interacts with the capital rental market. The assumption that capital is subsidized at a rate of one hundred percent is made for simplicity and to provide stark results. It could be relaxed at the expense of some additional notation, with the main insights being essentially unchanged.

We further assume that individual-specific taxes and subsidies are constant over time. This assumption captures the fact that it is hard to change policies that favor particular groups once they are instituted (Sowell, 1990; Krueger, 1993; Bridgman et al., 2009).[5]

2.3. Credit (capital rental) markets

Individuals have access to competitive financial intermediaries, who receive deposits and rent out capital at rate R to entrepreneurs. We restrict the analysis to the case where credit transactions are within a period—that is, individuals' financial wealth is restricted to be non-negative ($a \geqslant 0$). The zero-profit condition of the intermediaries implies $R = r + \delta$, where r is the deposit rate and δ is the depreciation rate.

Capital rental by entrepreneurs is limited by imperfect enforceability of contracts. In particular, we assume that, after production has taken place, entrepreneurs may renege on the contracts. In such cases, a defaulting entrepreneur i can keep a fraction $1-\phi$ of the undepreciated capital that is not government-provided and the after-tax revenue net of labor payments. The punishment is the garnishment of their financial assets (a_i) deposited with the financial intermediary. In the

[5] See Fernandez and Rodrik (1991) and Coate and Morris (1999) for models of the persistence of policies.

following period, the entrepreneur in default regains access to financial markets, and is not treated any differently, despite his history of default.[6]

Here we index by ϕ the strength of an economy's legal institutions that enforce contractual obligations. This one-dimensional parameter captures the extent of frictions in the financial market owing to imperfect enforcement of credit contracts. This parsimonious specification allows for a flexible modeling of limited commitment that spans economies with no credit market ($\phi = 0$) and those with perfect-credit markets ($\phi = 1$).

We consider equilibria in which the borrowing and capital rental contracts are incentive-compatible and are hence fulfilled. In particular, we study equilibria where the rental of capital is quantity-restricted by an upper bound $\bar{k}(a_i, z_i, \kappa_i, \tau_i; \phi)$, which is a function of the individual state $(a_i, z_i, \kappa_i, \tau_i)$. In what follows, we derive this constraint.

The static profit-maximization problem of an entrepreneur i is shown below:

$$\max_{k_m, k_p, l} (1-\tau_i) z_i f(k_m + k_p, l) - wl - Rk_m$$
$$\text{s.t.} \quad k_p \leqslant \kappa_i, \qquad k_m + k_p \leqslant \bar{k}(a_i, z_i, \kappa_i, \tau_i; \phi).$$

We denote by k_p the free capital provided by the government subject to individual-specific limit κ_i, and by k_m the capital rented through the capital market. The total capital rented, $k = k_m + k_p$ must satisfy the endogenous collateral constraint, which we formally define below. Because the government-provided capital is free, a profit-maximizing entrepreneur will tap into the capital market only after exhausting κ_i: that is, $k_m > 0$ only if $k_p = \kappa_i$. We will utilize this fact from now on to simplify notation.

The following proposition, a simpler version of which is proved in Buera et al. (2011), provides a characterization of the set of enforceable contracts and the rental limit $\bar{k}(a_i, z_i, \kappa_i, \tau_i; \phi)$.

Proposition 1. *Capital rental k by an entrepreneur with wealth a_i, talent z_i, individual-specific subsidized capital limit κ_i, and tax τ_i is enforceable if and only if*

$$\begin{aligned} &\max_l \left\{(1-\tau_i) z_i f(k,l) - wl\right\} - R \max\{k - \kappa_i, 0\} + (1+r) a_i \\ &\geqslant (1-\phi)\left[\max_l \left\{(1-\tau_i) z_i f(k,l) - wl\right\} + (1-\delta) \max\{k - \kappa_i, 0\}\right]. \end{aligned} \tag{2}$$

The upper bound on capital rental that is consistent with entrepreneurs choosing to abide by their contracts can be represented by a function $\bar{k}(a_i, z_i, \kappa_i, \tau_i; \phi)$, which is increasing in a_i, z_i, κ_i, $1-\tau_i$, and ϕ.

Condition (2) states that an entrepreneur must end up with (weakly) more economic resources when he fulfills his credit obligations (left-hand side) than when he defaults (right-hand side). This static condition is sufficient to characterize enforceable allocations because we assume that defaulting entrepreneurs regain full access to financial markets in the following period.

This condition is trivially satisfied for $k = \kappa_i$; that is, $\bar{k}(a_i, z_i, \kappa_i, \tau_i; \phi) \geqslant \kappa_i$. Since an entrepreneur can use up to κ_i of capital at no cost, paid by the government, he will choose $k \geqslant \kappa_i$.

This proposition also provides a convenient way to operationalize the enforceability constraint into a simple rental limit $\bar{k}(a_i, z_i, \kappa_i, \tau_i; \phi)$. Rental limits increase with wealth, because the punishment for defaulting (loss of collateral) is larger. Similarly, rental limits increase with z and $1-\tau_i$ because defaulting entrepreneurs keep only a fraction $1-\phi$ of the output. Most important, the subsidized capital limit κ_i relaxes an entrepreneur's capital rental constraint: A higher κ_i raises the value of not defaulting (left-hand side) through the reimbursement of capital rental cost, and reduces the value of defaulting (right-hand side) because we assume that government-provided capital is fully recovered by the government.[7]

2.4. Recursive representation of individuals' problem

The problem of an individual can be formulated recursively. For ease of exposition we here focus on stationary equilibria in which prices as well as taxes and subsidies are constant over time.

Individuals maximize (1) by choosing consumption, financial wealth, occupations, and capital/labor input if they choose to be entrepreneurs, subject to period budget constraints and capital rental limits.

At the beginning of a period, an individual's state is summarized by his wealth a_i, talent z_i, individual-specific subsidized capital limit κ_i, and output tax τ_i. He then chooses whether to be a worker or an entrepreneur for the period. We now

[6] The purpose of assuming that defaulting entrepreneurs maintain their access to subsidized capital in the future is to keep the rental limit tractable. A more natural assumption may be that defaulting entrepreneurs lose their subsidy forever. This would result in rental limits that are even more responsive to κ_i.

[7] This last assumption ensures that an entrepreneur can rent at least κ_i, even if $a_i = 0$ and $\phi = 0$. Alternatively we can justify it by assuming that the government will deny all future subsidy to those entrepreneurs that default on the government. In our numerical exercises, given the discount factor and the size of the subsidy we consider, the permanent loss of subsidy is sufficient penalty to deter any default on government-provided capital.

suppress the subscript i for notational convenience. The value for him at this stage, $v(a,z,\kappa,\tau)$, is the maximum over the value of being a worker, $v^W(a,z,\kappa,\tau)$, and the value of being an entrepreneur, $v^E(a,z,\kappa,\tau)$:

$$v(a,z,\kappa,\tau) = \max\{v^W(a,z,\kappa,\tau), v^E(a,z,\kappa,\tau)\}. \tag{3}$$

Note that the value of being a worker, $v^W(a,z,\kappa,\tau)$, depends on his entrepreneurial idea z, which may be implemented at a later date. We denote the optimal occupation choice by $o(a,z,\kappa,\tau) \in \{W, E\}$.

As a worker, an individual chooses consumption c and the next period's assets a' to maximize his continuation value subject to the period budget constraint:

$$\begin{aligned} v^W(a,z,\kappa,\tau) &= \max_{c,a'\geqslant 0} u(c) + \beta\left\{\gamma v(a',z,\kappa,\tau) + (1-\gamma)\int v(a',z',\kappa,\tau)\mu(z')\,dz'\right\} \\ \text{s.t.}\quad & c + a' \leqslant w + (1+r)a, \end{aligned} \tag{4}$$

where w is the steady state wage rate. The continuation value is a function of the end-of-period state (a',z',κ,τ), where $z' = z$ with probability γ and $z' \sim \mu(z')$ with probability $1-\gamma$. Recall that κ and τ are fixed over time for any given individual. In the next period, he will face an occupational choice again, and the function $v(a,z,\kappa,\tau)$ appears in the continuation value.

Alternatively, an individual can choose to become an entrepreneur. The value function of being an entrepreneur is as follows:

$$\begin{aligned} v^E(a,z,\kappa,\tau) &= \max_{c,a',k,l\geqslant 0} u(c) + \beta\left\{\gamma v(a',z,\kappa,\tau) + (1-\gamma)\int v(a',z',\kappa,\tau)\mu(z')\,dz'\right\} \\ \text{s.t.}\quad & c + a' \leqslant (1-\tau)zf(k,l) - wl - R\max\{k-\kappa,0\} + (1+r)a, \\ & k \leqslant \bar{k}(a,z,\kappa,\tau;\phi). \end{aligned} \tag{5}$$

Note that an entrepreneur's income is given by after-tax profit plus the return to his initial wealth, and that his choice of capital input is bounded from above by the endogenous collateral constraint $\bar{k}(a,z,\kappa,\tau;\phi)$. We denote by $l(a,z,\kappa,\tau)$ the number of workers hired by an individual entrepreneur, and by $k(a,z,\kappa,\tau)$ the units of capital used for production. We also let $y(a,z,\kappa,\tau)$ be the corresponding output, $zf(k,l)$.

2.5. Small open economy equilibrium

We assume a small open economy, with the interest rate r exogenously given by a large economy with perfect-credit markets—see Section 3. A stationary competitive equilibrium of our economy can be defined in the usual way. That is, individuals solve (3)–(5) taking as given the wage and the interest rate, and the labor market clears. To more formally define the labor market clearing condition, we first denote by $G(a,z,\kappa,\tau)$ the joint cumulative distribution function of wealth, entrepreneurial productivity, individual-specific guarantee of free capital, and taxes. Then we obtain:

$$\int_{\{o(a,z,\kappa,\tau)=E\}} l(a,z,\kappa,\tau)\,dG(a,z,\kappa,\tau) = \int_{\{o(a,z,\kappa,\tau)=W\}} dG(a,z,\kappa,\tau). \tag{Labor market}$$

In the calculations that follow, we will assume that we start in a steady state with no tax, subsidy or government debt. We then introduce constant taxes and subsidies subject to an intertemporal government budget constraint, and, as a result, the new steady state that the economy evolves to will have some constant level of debt, denoted by B. The government surplus in the new steady state should be equal to the interest payment on B:

$$rB = \int_{\{o(a,z,\kappa,\tau)=E\}} \left[\tau y(a,z,\kappa,\tau) - (r+\delta)\min\{\kappa, k(a,z,\kappa,\tau)\}\right] dG(a,z,\kappa,\tau).$$

3. Calibration

In order to explore the quantitative significance of our theory of idiosyncratic distortions, we assign values to the various preference and technology parameters of the model, and choose the policies that are intended to alleviate credit constraints.

To be clear, the goal of our quantitative exercise is not the replication of particular episodes of economic transitions in the data. Rather, we are asking whether our model is capable of generating a quantitatively significant impact on the macroeconomy for empirically reasonable parameters.[8]

Since less developed countries tend to engage more actively in the economy-wide industrial policies that we consider here, ideally we would use data from such countries for calibration. However, not all the data we need from these countries

[8] In this regard, one can argue that our quantitative exercises are in the spirit of Restuccia and Rogerson (2008).

Table 1
Parameter values.

Target moments	US data	Model	Parameter
Top ten-percentile employment share	0.69	0.69	$\eta = 4.84$
Top five-percentile earnings share	0.30	0.30	$\alpha + \theta = 0.79$
Establishment exit rate	0.10	0.10	$\gamma = 0.89$
Interest rate	0.04	0.04	$\beta = 0.92$
Target moments	Indian data	Model	Parameter
Top ten-percentile employment share	0.58	0.58	$\eta = 5.56$
External finance to GDP ratio	0.30	0.30	$\phi = 0.17$

are readily available. For this reason, we first calibrate preference and technology parameters so that the perfect-credit benchmark without tax and subsidy matches key aspects of the United States, a relatively undistorted economy. We then assume that less developed countries are different from the US in two dimensions: financial frictions and the distribution of entrepreneurial productivity. We use relevant data from India to partially recalibrate the model.

Our target moments pertain to standard macroeconomic aggregates and income distribution, as well as establishment size distribution and dynamics. For the first part of the calibration—i.e., the US as the perfect-credit benchmark—we work with a closed economy version of our model, and we use the interest rate as a target moment.

We need to specify values for seven parameters: two technological parameters, α, θ, and the depreciation rate δ; two parameters describing the process for entrepreneurial talent, the survival probability of entrepreneurial ideas γ and the Pareto tail parameter η; the subjective discount factor β, and the coefficient of relative risk aversion σ. Of these seven parameters, η will be recalibrated below for our analysis of developing countries.

Following much of the literature, we set $\sigma = 1.5$ and $\delta = 0.06$. We also match a capital share of 0.3, which in our model implies that $\alpha/(1/\eta + \alpha + \theta) = 0.3$, assuming that entrepreneurial income is split into capital and labor income in the same proportion as is non-entrepreneurial income (Gollin, 2002).

We require four additional moments in order to pin down the model's parameters. The four moments we choose are the employment share of the top decile of establishments; the share of earnings generated by the top five percent of earners; the annual exit rate of establishments; and the annual real interest rate. We know that the fat upper tail is a key feature of the empirical establishment size distribution, and the Pareto tail parameter is important for the employment concentration in the upper tail. Given the returns to scale, $\alpha + \theta$, we choose the tail parameter of the entrepreneurial talent distribution, $\eta = 4.84$, to match the employment share of the largest ten percent of establishments, 0.69. We can then infer $\alpha + \theta = 0.79$ from the earnings share of the top five percent of earners. Top earners are mostly entrepreneurs (both in the US data and in the model), and $\alpha + \theta$ controls the fraction of output going to the entrepreneurial input. The parameter $\gamma = 0.89$ leads to an annual establishment exit rate of ten percent in the model.[9] This is consistent with the exit rate of establishments reported in the US Census Business Dynamics Statistics.[10] Finally, the model requires a discount factor of $\beta = 0.92$ to match the annual interest rate of four percent.

We use the above parameter values calibrated to the US data for our exercise, with two important exceptions, because we are considering industrial policies implemented in less developed countries with underdeveloped financial markets. First, the establishment size distribution in less developed countries is starkly different from that of the US. Using detailed micro-level data for India, a country chosen for the availability of such data, we compute the employment share of the largest ten percent of establishments to be 0.58, which is obtained in the model with $\eta = 5.56$.[11] Second, we set $\phi = 0.17$ to generate an external finance to GDP ratio of 0.3 in the model, which is the average for the years 2000 through 2005 in the Indian data, where external finance is defined as private credit by deposit money banks and other financial institutions plus private bond market capitalization. This number comes from the data set constructed by Beck et al. (2000).[12] These two parameters are jointly recalibrated.[13] (See Table 1.)

[9] Note that $1 - \gamma$ is larger than 0.1, because a fraction of those hit by the idea shock chooses to remain in business. Entrepreneurs exit only if their new idea is below the equilibrium cutoff level.

[10] We also considered an alternative specification where the probability of losing one's entrepreneurial productivity $(1 - \gamma)$ is negatively correlated with the productivity level (z), to generate a negative correlation between exit rate and establishment size. With the exit rates conditional on z ranging from 0.05 to 0.15, and the unconditional exit rate held at 0.1, the quantitative results are fairly similar to the benchmark where $1 - \gamma$ is invariant to z. One key difference though is that the temporary positive effect of the subsidy policies lasts longer than in the benchmark, since the initial subsidy recipients maintain their high productivity for longer on average now—see Sections 4.1 and 4.2. Nevertheless, because the main results are more or less the same, we opt for the parsimonious parameterization of a constant $1 - \gamma$.

[11] Without this recalibration of η, the impact of the tax–subsidy policies will be larger both in the short run and the long run by 20–30 percent. Intuitively, more dispersion of the individual productivity implies more room for resource misallocation across heterogeneous producers, be it through financial frictions or idiosyncratic taxes/subsidies. We recalibrate η to avoid exaggerating the effect of the tax–subsidy policies.

[12] India is typical of less developed countries in this dimension. The average of the external finance to GDP ratios, defined in the same way, across non-high income countries in the Beck et al. data for the year 2000 is 0.32.

[13] Although the underlying entrepreneurial productivity follows a Pareto distribution, the resulting establishment size distribution does not, because of financial frictions. Our model matches the Indian data partly because of the higher η but also because of ϕ not being one. This contrasts with Guner et al. (2008)—and to some extent the reality—where the lack of large firms is attributable to regulations that are explicitly contingent on firm size.

We do not recalibrate other parameters, mainly because we do not have Indian data on establishment dynamics or income concentration: We hold fixed the persistence of the productivity shock (γ) and the parameters of the entrepreneurial technology (α and θ).[14]

4. Impact of industrial policies

We study the development dynamics of an economy whose government chooses subsidies and taxes to increase short-run output, by subsidizing productive entrepreneurs who face capital rental constraints. We assume that subsidies get entrenched once given out, and therefore remain in place independently of the future productivity of the subsidized entrepreneur.

In our model, the government has an advantage over the private sector as it can freely redistribute resources across periods and across individuals. This provides a simple rationale for government interventions. While this framework abstracts from other frictions that make a less compelling case for government interventions, we adopt it because it allows us to clearly highlight the negative long-run consequences of well-intended policies if they cannot be easily adjusted over time.[15]

We assume that governments are short-sighted and choose taxes and subsidies to increase current output, reflecting the fact that politicians do not expect to remain in power for long periods of time, and the fact that politicians tend to have different preferences (Alesina and Tabellini, 1990). An alternative assumption yielding similar results is that politicians are "naive" and do not understand that policies will be hard to alter once implemented. A politician who thinks he can completely re-optimize a given policy—i.e. select different subsidy recipients—every year will act as if he plans for a time horizon of only one year. In this sense, "myopia" and "naïveté" on the part of politicians are equivalent assumptions. The distinction matters only for whether we can talk of "unintended consequences of well-intended policies." If politicians are naive, a policy's long-run effects are truly unintended. If instead they are myopic, any negative long-run effects are fully intentional and only due to the politicians' short time horizon.

4.1. Taxes and subsidies

Initially, the economy is in a steady state with no tax or subsidy (i.e., $\tau_i = \kappa_i = 0$ for all i). At time 0, the government introduces individual-specific subsidized capital κ_i, financed by output taxes τ_i. For the individuals in the economy, this is a completely unexpected shock, but they understand that it is a permanent policy change.

We operationalize the policy in the following manner. We assume that the government selects a fraction λ of the population to be eligible for subsidized capital. For all recipients, we assume $\kappa_i = \bar{\kappa} > 0$ and $\tau_i = 0$. For the remaining $1 - \lambda$ fraction of the population, they are given $\kappa_i = 0$ and $\tau_i = \bar{\tau} > 0$. We emphasize that, once given, these individual-specific tax and subsidy remain constant over time.

For the following numerical exercise, we assume that the government chooses $\lambda = 0.01$. In particular, we assume that the government gives subsidies to the fraction $\lambda = 0.01$ of individuals whose output in the current period will increase the most when subsidized. These are typically poor, high-ability individuals whose financial constraints are relaxed the most by the subsidy. In fact, some of them would choose to be workers were it not for the subsidized capital.

To pay for the subsidized capital, the government sets $\bar{\tau} = 0.1$. Finally, $\bar{\kappa}$ is chosen to satisfy the government budget constraint in present value, computed at the world interest rate $r = 0.04$. This yields $\bar{\kappa} = 17.0$, which amounts to one and a half times the average capital used by entrepreneurs in the initial period. The size of this industrial policy is rather large: In the new steady state, the subsidy is about 7 percent of the GDP. However, this number is not outlandish if one thinks of the resources controlled by many developing country governments, which are typically channeled into public or state-owned enterprises.

As noted earlier in the paper, we do not aim to replicate particular episodes of economic transitions in the data using our numerical exercises. Rather, we use them to assess the magnitude of the macroeconomic impact of industrial policies in the short run and the long run. As such, we focus on qualitative aspects that will be scaled up and down by changes in the size of the program.

The gray area in the left panel of Fig. 1 illustrates the set of subsidized individuals in terms of their time zero entrepreneurial ability (horizontal axis) and wealth (vertical axis). These are high entrepreneurial ability and low wealth individuals. This panel also shows the initial occupation choice prior to the introduction of taxes and subsidies. The solid line divides the plane into those individuals that choose to be workers in the absence of subsidies, i.e. individuals with too little wealth and/or ability, and those that choose to be entrepreneurs. In our exercise, all subsidy recipients choose to be entrepreneurs, and hence the gray area to the southwest of the occupation choice line represents those who switch their occupation from worker to entrepreneur because of the subsidy.

[14] The effects of adjusting ϕ and η on the moments that primarily pinned down γ, α, and θ in the perfect-credit benchmark are relatively minor: The capital share is unaffected, given our division of entrepreneurial income, while the top five-percentile earnings share increases to 0.32 and the exit rate decreases to 0.08.

[15] A richer model of financial frictions would incorporate the fact that entrepreneurs have private information about their productivity, which limits the extent to which they can borrow to finance their project. In this case, it is natural to assume that governments *do not* have an informational advantage over the private sector, and therefore, they cannot easily pick winners (Harberger, 1998).

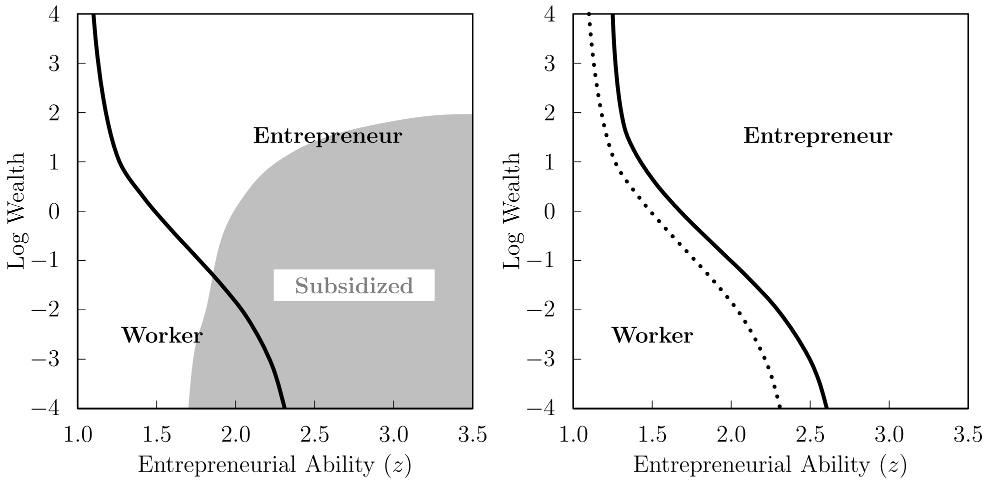

Fig. 1. Occupational choice and subsidy recipients. In the left panel, the solid line demarcates the initial worker–entrepreneur choice in the absence of taxes and subsidies for a given wealth–ability pair. Those with too little wealth and/or too low an ability become workers (southwest of the line). The gray area is the selected subsidy recipients. Given the government's selection criterion, those with the highest marginal product of capital are provided with subsidized capital. They tend to be of a high ability but poor. In the right panel, we show the occupation choice following the implementation of the tax–subsidy policies. In particular, the solid line represents the occupation choice of those who are not subsidized. (For comparison, we reproduce the original occupation choice line with a dotted line.) Those subsidized all become entrepreneurs, and their choice is not shown.

In the right panel, we show the occupation choice immediately following the introduction of taxes and subsidies. In particular, the solid line stands for the occupation choice of those who are not subsidized. When compared to the pre-policy occupation choice, replicated using a dotted line, their occupation choice line now lies above and to the right. That is, for those unsubsidized, entrepreneurship now calls for higher ability and/or more wealth.[16] One reason for this is the direct impact of the revenue tax ($\bar{\tau} = 0.1$) that they now face, and the other is the equilibrium wage, which is driven up three percent by the increased labor demand of the subsidized entrepreneurs.

4.2. Economic effects

We now turn to the aggregate implications of the tax/subsidy policy. The policy is implemented at $t = 0$, and the government starts out by subsidizing individuals who are most productive and financially constrained as of $t = 0$. This relaxes the constraint of the productive entrepreneurs. In addition, it allows some productive but poor entrepreneurs, who would have remained workers in the absence of the subsidy, to start businesses. As a result, the economy expands.

Fig. 2 shows the transitional dynamics of GDP and aggregate TFP, both normalized by their respective levels in the pre-intervention steady state.[17] The horizontal axis is measuring years. Output (black line) jumps up upon impact, driven by a rise in aggregate TFP (gray line) and surge in the use of capital by subsidized individuals. The fact that GDP jumps up by a higher percentage than TFP is due to the fact that in our small open economy an increase in TFP triggers capital inflows. If the economy were instead closed so that the aggregate capital stock is fixed on impact, the capital stock would build up only slowly over time. GDP would jump up by the same percentage as TFP on impact, and then gradually increase further in line with the dynamics of the capital stock.

The temporary rise in aggregate TFP reflects the better allocation of resources toward the productive, constrained entrepreneurs. However, TFP declines monotonically over time. This is the result of, first, the mean-reversion in the entrepreneurial productivity process and, second, the assumption that the individual-specific subsidies are irreversible. By the fourth year of the policy, TFP falls below the pre-intervention level, as the subsidy recipients are now less likely to be more productive than other unsubsidized individuals. GDP stays above its initial level for another ten years, because the subsidies relax the financial constraint and allow for larger capital input.

The negative long-run consequences of the tax/subsidy policy are significant. Compared to the aggregate TFP in the initial steady state without taxes and subsidies, the TFP in the new steady state is about 10 percent lower. To put this number in perspective, we note that the TFP in the initial steady state, where the only distortions are caused by financial frictions, is only 11 percent lower than the TFP of the corresponding perfect-credit economy. One interpretation is that, to recover 30 percent of the TFP loss due to financial frictions (the initial increase in TFP of 3 percent divided by the 11 percent loss) in the short run, the well-intended policies will leave behind long-term damages that are almost as large as the original TFP

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[16] The area between the solid line and the dotted line in the right panel hence represents the unsubsidized individuals who switch their occupation from entrepreneur to worker because of the policy.

[17] We compute TFP as $YK^{-1/3}L^{-2/3}$, where Y is GDP, K is aggregate capital, and L is the size of the labor force, inclusive of both workers and entrepreneurs.

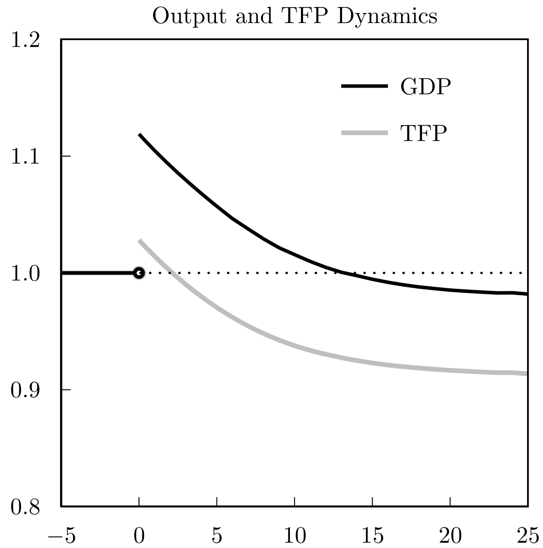

Fig. 2. Transition under industrial policy. This figure shows the dynamics of GDP and TFP, normalized by their respective values prior to the policy implementation. The tax and subsidy policy is implemented in year 0, and the horizontal axis is measuring years.

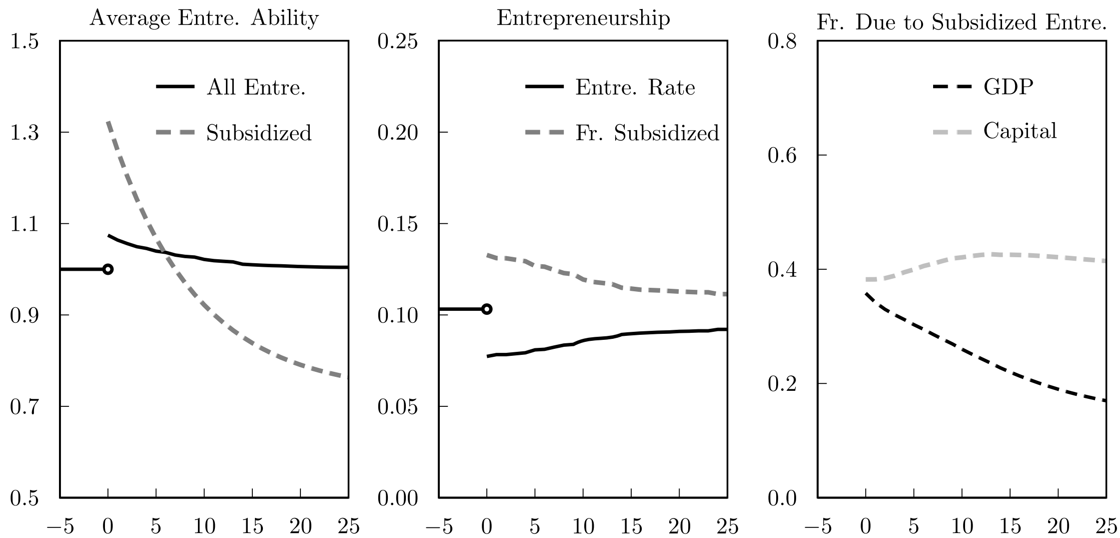

Fig. 3. Transition under industrial policy. In the left panel, we show the average entrepreneurial ability with a solid line, and also the average ability of the subsidized entrepreneurs with a dashed line. Both are normalized by the average entrepreneurial ability prior to the policy implementation. The solid line in the center panel shows what fraction of the population chooses to be entrepreneurs (i.e., entrepreneurship rate), and the dashed line traces what fraction of the active entrepreneurs are the subsidized ones. Finally, in the right panel, we show what fraction of GDP is produced by the subsidy recipients, and what fraction of aggregate capital is used for production by the subsidy recipients.

loss due to financial frictions. However, in Section 5.1, we show that this trade-off between short-term gains and long-term costs is not linear: The long-term costs are increasing in a convex fashion in relation to the possible short-term gains.

To gain more insight into the economics behind the time-series changes in aggregate output and TFP, it is useful to look more closely at how occupational choices evolve over time. Fig. 3 presents the relevant information.

The left panel of Fig. 3 shows the average ability of all entrepreneurs (solid line) and that of subsidized entrepreneurs (dashed line), both normalized by the average entrepreneurial ability in the pre-intervention equilibrium. Initially, the subsidized ones are more productive than the rest, as the subsidy is targeted toward the high-z individuals. Nevertheless, as time passes, individual abilities mean-revert so that the average ability of this group decreases. As a result the subsidy props up incompetent entrepreneurs—who would exit without it—in the long run, with negative consequences on aggregate output and productivity.

The center panel of Fig. 3 shows the time series of the number of active entrepreneurs in the economy. Upon impact, the number of entrepreneurs per capita decreases from about 0.1 to 0.08 (solid line), with 13 percent of all entrepreneurs being the subsidized ones (dashed line). This fact is not surprising given that the profitability of a majority of the original entrepreneurs is negatively affected by the tax ($\bar{\tau} = 0.1$) needed to finance credit subsidies and also the higher equilibrium wage. (Recall the discussion following Fig. 1.) The exit of taxed entrepreneurs is only partially compensated by the entry of the relatively fewer, but more capitalized, subsidized entrepreneurs. Over time, as the productivity of the subsidized entrepreneurs reverts to the mean, they accordingly downsize, demanding less labor and, hence, depressing the wage. This leads to more entry among unsubsidized entrepreneurs, who are now more likely to have a high productivity z than the subsidized ones. In fact, for the unsubsidized entrepreneurs, the entry threshold in terms of z is so high that the average z over all active entrepreneurs in the new steady state is slightly higher than that in the initial steady state. (The solid line in the left panel asymptotes to a number slightly greater than one.)

Having said all this, we emphasize that it is how production factors are distributed among active entrepreneurs that explains the low aggregate TFP in the long run. The right panel of Fig. 3 is useful for clarifying this point. The subsidized minority maintains a disproportionate influence on the aggregate economy. While they are a small fraction of the population (again, $\lambda = 0.01$), they account for 12 percent of active entrepreneurs in the new steady state (dashed line, center panel). More important, because credit subsidies naturally relax the financial constraints of recipients, in the long run, subsidized entrepreneurs use almost 75 percent of all the external financing in the economy, and almost 40 percent of all the capital in the economy. The gray dashed line in the right panel of Fig. 3 shows what fraction of capital is used by subsidized entrepreneurs in each period. Similarly, the black dashed line shows the fraction of output produced by subsidy recipients. While their share of capital input remains more or less constant, because of the mean-reversion in the ability process, they contribute less and less of aggregate output, adversely affecting aggregate TFP in the long run. On the other hand, the unsubsidized high-ability individuals face revenue taxes ($\bar{\tau}$) and operate at a smaller scale. The tax also tightens their collateral constraint, as stated in Proposition 1. Furthermore, given smaller profits, they have a harder time growing over time by overcoming financial constraints through self-financing. These facts also partly explain the lower TFP in the long run.

Finally, we compute the welfare impact of the tax–subsidy policy. It is obvious that the selected subsidy recipients benefit, while the rest, 99 percent of the population ($1 - \lambda = 0.99$), are made worse off. With welfare changes measured in units of permanent consumption, the welfare gains of the subsidy recipient are on average tantamount to 600 percent, and the average welfare loss to the remainder of the population is about 6 percent. If we weight each individual's utility equally and use a utilitarian welfare function, the welfare of the entire economy goes down by about 5 percent with the policy.

4.3. Miracles followed by disasters

How do the aggregate implications of our theory compare with the evidence on temporary miracles followed by disasters? Our theory performs well in some dimensions but less so in others. In the experiments presented in this section, temporary miracles are mainly driven by a burst of capital accumulation and a modest rise in TFP. This feature is at odds with the data in Jones and Olken (2008) and Hausmann et al. (2005), which show that temporary miracles are mostly driven by a surge in TFP. A natural way to bring our theory closer to the data would be to consider a closed economy version, in which the capitalization of subsidized entrepreneurs will have to come through reallocation of domestic capital, as opposed to capital inflows. In a closed economy, the initial reallocation of capital towards more productive, subsidized entrepreneurs would also result in a much stronger rise in TFP.

Another clear implication of our theory is that we should observe an increase in the ratio of external finance to GDP following the implementation of the type of well-intended policies simulated in this section. In our exercise, this ratio rises by 0.2 from 0.3 to 0.5. In the data, this ratio increases during most growth acceleration episodes, and by comparable magnitudes. Of the nine countries in Jones and Olken (2008) that experienced an upward structural break in growth followed by a downward break (i.e., temporary miracle followed by failure), we have available data on external finance for seven. The external finance to GDP ratio increased in six of the seven countries, with an average increment of 0.2 in the first seven years following the upward break in growth.[18] For the countries in Hausmann et al. (2005), 16 experienced a growth acceleration in some year t followed by negative growth in the interval $[t + 8, t + 10]$, which can be interpreted as a temporary miracle followed by failure. Relevant data are available for only nine of them, and the external finance to GDP ratio increased in six of the nine, with an average increment of 0.12. In this context, we conclude that the tax and subsidy rates we consider are of reasonable magnitudes, even though they are not calibrated to data.

All in all, our model generates a short-run boost in GDP (lasting for more than a decade) that precedes a permanent negative impact on economic performance accompanied by an increase in the ratio of external finance to GDP, consistent with the patterns in the data. Incidentally, this model prediction can be thought of as an explanation for why financial development—if measured by external finance to GDP ratios alone—does not necessarily lead to economic growth even in the medium term: What matters even more is how the externally-financed capital is allocated among heterogeneous producers.

This success, however, needs to be qualified by our model's shortcomings in terms of explaining the joint dynamics of TFP and aggregate capital.

[18] The only exception is Papua New Guinea. The range of the increase in the ratio runs from −0.08 (Papua New Guinea) to 0.44 (Thailand).

Table 2
Measure of distortions in the economy.

$\log\tau_{m,i}$	$t=0-$	$t=0+$	$t=+\infty$
Variance	0.3603	0.1679	0.6246
Corr. w/z_i	0.4784	0.0929	0.5852

4.4. Measuring idiosyncratic distortions

To evaluate the quantitative role of our theory on the origin of idiosyncratic distortions, we compute measures of idiosyncratic distortions in our model and compare them to the same statistics computed from developing country data. In particular, to measure idiosyncratic distortions, we follow Hsieh and Klenow (2009) and introduce "wedges" $\tau_{y,i}$ and $\tau_{k,i}$ that transform the static profit-maximization problem of an entrepreneur into:

$$\max_{k_i,l_i}(1-\tau_{y,i})z_i k_i^{\alpha} l_i^{\theta} - wl_i - (1+\tau_{k,i})(r+\delta)k_i.$$

Using the observed output and input choices, we back out $\tau_{y,i}$ and $\tau_{k,i}$, and then compute their weighted average:

$$\tau_{m,i} = \frac{(1+\tau_{k,i})^{\alpha}}{(1-\tau_{y,i})}.$$

We use $\log\tau_{m,i}$ as our measure of idiosyncratic distortions. Clearly, the distortions not only capture taxes and idiosyncratic subsidies, but also the financial frictions in the economy.

The moments reported in Table 2 are computed over the set of active entrepreneurs in the pre-intervention steady state ($t=0-$), upon the implementation of the policy ($t=0+$), and in the new steady state ($t=+\infty$).

In the initial steady state ($t=0-$), there is no tax on revenue or capital subsidy—i.e., $\bar{\tau}_i=\bar{\kappa}_i=0$ and hence $\tau_{y,i}=0$ for all i. There still are financial frictions, which are captured by $\tau_{k,i}$. The measured variance of $\log\tau_{m,i}$ is 0.36, which is equal to the variance of $\alpha\log(1+\tau_{k,i})$. In addition, $\tau_{m,i}$ is positively correlated with entrepreneurial productivity z_i. Although financial frictions are systematic and not individual-specific, they particularly bind for those with high z_i, whose optimal scale of production and hence external financing needs are large. This explains the positive correlation. Restuccia and Rogerson (2008) show that idiosyncratic distortions have large effects when they are positively correlated with individual productivity. While this positive correlation is exogenously imposed in Restuccia and Rogerson's analysis, we obtain it endogenously with financial frictions that are common to all firms.

At time 0, the government implements the tax/subsidy policy. While the government subsidizes the most productive entrepreneurs initially, the subsidy will remain with these same individuals regardless of their future productivity.

Upon impact ($t=0+$), the subsidy relaxes the financial constraints of productive entrepreneurs, and the dispersion of $\tau_{k,i}$ decreases. Although the dispersion of $\tau_{y,i}$ is now non-zero, the overall distortion measure, $\log\tau_{m,i}$, becomes less dispersed, with the variance decreasing to 0.17. Because it is the high-z_i entrepreneurs who get subsidized—which shows up as a lower $\tau_{m,i}$—the correlation between $\log\tau_{m,i}$ and z_i weakens, from 0.48 to 0.09. This is the flip side of the initial increase in the aggregate TFP of the economy (Fig. 2).

However, as time goes on, the productivity of the subsidized individuals gradually reverts to the mean. In the new steady state ($t=+\infty$), the majority of high-z individuals are not subsidized but taxed, and, because of the revenue tax $\bar{\tau}$, they face financial constraints that are more stringent than in the initial steady state.[19] At the same time, the subsidies prop up those with low productivity, who would have exited without the subsidy. There are two consequences. First, the variance of $\log\tau_{m,i}$ is substantially larger than in the initial steady state, 0.62 versus 0.36.[20] Second, because of the low-z entrepreneurs who now remain active owing to the subsidy (i.e., low $\tau_{m,i}$), the correlation between z_i and $\log\tau_{m,i}$ is now even more strongly positive than in the initial steady state. That is, the endogenous positive correlation between idiosyncratic distortions and z_i coming from the financial frictions is now further strengthened by the presence of subsidized low-z entrepreneurs with low $\tau_{m,i}$ who would exit without the subsidy. This positive correlation between z_i and $\tau_{m,i}$ is consistent with the empirical findings of Guner et al. (2008), although in their theory size-dependent policies are the cause of this correlation.

Bartelsman et al. (forthcoming) show a set of related evidence. They compute the correlation between a firm's labor productivity and its size (i.e., the number of employees), and a positive correlation between the two is informative about aggregate TFP. They find that this correlation is much weaker in poor countries with low aggregate TFP. For comparison, we compute the correlation between the entrepreneurial productivity (z) and the log of the number of employees.[21] This

[19] Recall from Proposition 1 that the capital rental limit is increasing in $(1-\tau)z$: A higher τ means a tighter capital rental limit.

[20] Although our tax and subsidy parameters are not calibrated to any particular data, by coincidence, the variance of $\log\tau_{m,i}$ in the new steady state is comparable in magnitude to the 0.67–0.74 range measured from Chinese and Indian data in Hsieh and Klenow (2009).

[21] There is one caveat with this comparison. Bartelsman et al.'s labor productivity is a revenue-based measure, which must be equalized across all producers in an efficient allocation of our model. Note that Bartelsman et al. use a model with fixed costs, in which their labor productivity measure is correlated with physical productivity—and hence size—in an efficient allocation. With this distinction in mind, we compare the correlation that Bartelsman et al. focus on with the correlation between z and size in our model.

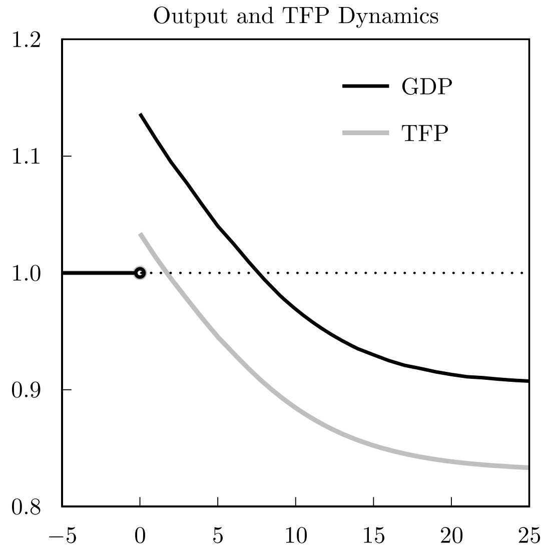

Fig. 4. Transition with higher taxes and subsidies. This figure shows the dynamics of GDP and TFP, normalized by their respective values prior to the policy implementation. The tax and subsidy policy is implemented in year 0, and the horizontal axis is measuring years.

correlation should be one in our economy without any friction or distortion. In the initial steady state ($t = 0-$), where there are financial frictions but no idiosyncratic taxes/subsidies, the correlation is 0.7. Immediately following the implementation of the tax/subsidy policy ($t = 0+$), the correlation increases to 0.83, consistent with the temporary increase in allocative efficiency and TFP. However, in the new steady state ($t = +\infty$), the correlation drops to 0.48, reflecting the negative long-run consequences of the industrial policy on resource allocation and TFP.

In summary, the results in this section suggest that our theory on the origin of idiosyncratic distortions can explain the dispersion of idiosyncratic distortions and their correlation with the establishment-level productivity observed in the available data.

5. Alternative policy experiments

We first increase the tax and subsidy rates to study how sensitive the macroeconomic outcomes are to these policy variables. We then relax the assumption that subsidies are given permanently to selected individuals, and explore the implications.

5.1. Higher tax and subsidy rates

In Section 4, we focus on qualitative aspects of the macroeconomic impact of industrial policies that can be scaled up and down by changes in the size of the program. Here we consider a policy with higher tax and subsidy rates. We use the same preference and technology parameters as in Section 3. As for the policy parameters, we hold λ, the fraction subsidized, fixed at 0.01, but increase $\bar{\tau}$ to 0.25 from 0.1. As in Section 4.1, we choose $\bar{\kappa}$ to satisfy the intertemporal budget constraint of the government, and arrive at $\bar{\kappa} = 30.4$. The size of this industrial policy is almost improbably large: In the new steady state, the subsidy is about 17 percent of the GDP. (In the numerical exercise in Section 4, the subsidy amounts to 7 percent of the GDP in the new steady state.) This exercise is designed to give a sense of how large the short-run and the long-run effects of industrial policies can be.

As in Section 4.1, subsidies go to those individuals whose output will increase the most with them, and the individual-specific subsidies are permanent, regardless of the recipients' future productivity.

Fig. 4 shows the transition dynamics of GDP and TFP with the higher taxes and subsidies. When collated with Fig. 2, it reveals that, in terms of both GDP and TFP, as expected, the higher taxes and subsidies have larger positive effects in the short run *and* larger negative effects in the long run. However, the magnitude of the additional short-run gains is far smaller than that of the additional long-run costs. With $\bar{\tau} = 0.1$ and $\bar{\kappa} = 17.0$ as in Section 4, GDP increases by 12 percent above the initial level and then reaches the new steady state level that is 2 percent lower than the initial level (black line, Fig. 2). With $\bar{\tau} = 0.25$ and $\bar{\kappa} = 30.4$, GDP increases by 13 percent early on, but then is lower than the initial level by 10 percent in the long run (black line, Fig. 4). The TFP series show a similar pattern.

The substantial difference in the negative long-run impact is easy to understand: Larger subsidies to entrepreneurs with mediocre talent and higher taxes on everyone else push GDP and TFP lower. On the other hand, in the short run, the positive effect of the larger subsidies to productive, constrained entrepreneurs is partly offset by the detrimental effect of the higher taxes on everyone else. As a result, the larger intervention (i.e., higher taxes and subsidies) have only negligible

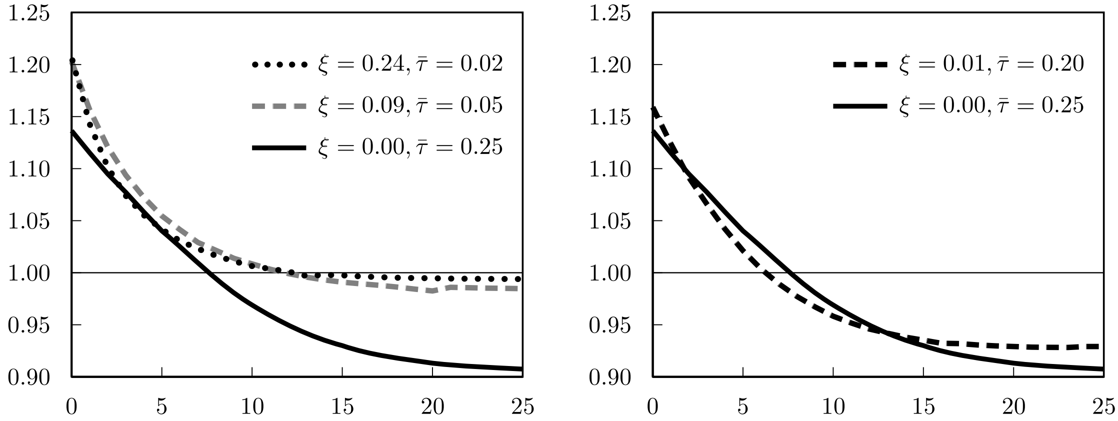

Fig. 5. GDP dynamics with expiring industrial policy. The vertical axis is measuring GDP, normalized by its level in the initial steady state. The horizontal axis is measuring years, with the policy being implemented in year 0.

additional positive effect in the short run. We conclude that the long-run costs of the tax and subsidy policies increase in a convex manner in relation to the possible short-run gains of such policies.

5.2. Stochastic expiration of industrial policies

In our analysis of Sections 4 and 5.1, we assume that, once given, individual-specific subsidies last permanently, regardless of the entrepreneurial productivity of the subsidy recipients in the future. This assumption, paired with the mean-reversion in entrepreneurial productivity, is behind the short-run benefits and long-run costs of the tax/subsidy policies. We now relax this assumption and consider stochastic expiration of subsidies. In particular, we ask how the short-run and long-run effects of the subsidy policy will change, if the government can credibly commit to retiring the subsidies over time.

We start with the higher taxes and subsidies considered in Section 5.1, rather than the main policy experiment in Section 4.1, to allow for a wider variability in the policy parameters of interest and hence more discernible differences in numerical results.

The model and the parameter values are the same as in Sections 3 and 5.1, including $\lambda = 0.01$, $\bar{\kappa} = 30.42$, and the identity of subsidy recipients in $t = 0$, but for two exceptions. First, now the initial subsidy recipients will lose the credit subsidy with probability ξ each period. (Our benchmark had $\xi = 0$.) The loss of subsidy is independent of their entrepreneurial productivity. Once they lose the subsidy, they will be subject to the output tax $\bar{\tau}$ as anyone else. After the initial period, there is no new recipient of subsidies. As a result, the fraction of subsidy recipients in the population in a given period t is $\lambda(1-\xi)^{t-1}$. Second, now that the government pays out less subsidy overall than in the $\xi = 0$ case, we reduce $\bar{\tau}$ accordingly to satisfy its intertemporal budget constraint.

In addition to the $\{\xi = 0, \bar{\tau} = 0.25\}$ benchmark, we explore three other cases: $\{\xi = 0.01, \bar{\tau} = 0.20\}$, $\{\xi = 0.09, \bar{\tau} = 0.05\}$, $\{\xi = 0.24, \bar{\tau} = 0.02\}$. It is clear that ξ and $\bar{\tau}$ have an inverse relationship, because a higher ξ implies a faster reduction in subsidy expenditures and hence a lower tax rate.

In Fig. 5, we plot the GDP time series for each case, starting from year 0 and normalized by the pre-intervention GDP level. (The horizontal axis is measuring years.) In the left panel, the solid line is the GDP from the $\xi = 0$ case as shown in Fig. 4. We first compare this with the dotted line, where a subsidy recipient loses his subsidy with probability 0.24 each year and the revenue tax rate is only 0.02.

Three observations can be made. First, in the long run, GDP is higher when subsidies expire stochastically than when they remain permanent. This is because, with expiring subsidies, the fraction of those with subsidies—i.e., idiosyncratic distortions—asymptotes to zero, and also because the revenue tax rate—another form of distortions—is much lower.

Second, even immediately after the introduction of the subsidies, GDP is higher with $\xi = 0.24$, although in both cases exactly the same individuals are given the same credit subsidies. This is because the lower $\bar{\tau}$ distorts the productive activity of unsubsidized entrepreneurs by less than in the $\xi = 0$ case.

Third, between years 3 and 5, the GDP with expiring subsidies dips slightly below that in the $\xi = 0$ benchmark, in spite of the lower tax. This is because there remain very few subsidy recipients with $\xi = 0.24$, when subsidies can still have positive effects on output by relaxing the credit constraint of the original subsidy recipients, who on average have higher z than unsubsidized entrepreneurs up to this point (left panel, Fig. 3).

This last observation is more evident, when we make a more localized comparison in terms of ξ and τ. In the left panel of Fig. 5, the GDP with $\{\xi = 0.24, \bar{\tau} = 0.02\}$ (dotted line) starts out higher than that with $\{\xi = 0.09, \bar{\tau} = 0.05\}$ (dashed line). However, it falls below the dashed line in year 1, and crosses it again only in year 12. In between, subsidies are still capable of boosting output by relaxing the credit constraints of productive entrepreneurs, and their faster removal with $\xi = 0.24$

pushes down output faster toward the long-run level. Finally, in the right panel, we compare the $\xi = 0$ case (solid line) with $\{\xi = 0.01, \bar{\tau} = 0.20\}$ (dashed line). The same pattern is present: Stochastic expiration of subsidies implies higher levels of output in the very short run and the long run, but lower levels in the intermediate term.[22]

Nevertheless, if the objective of the government is to temporarily increase the GDP of the economy with minimal long-run costs, it is advisable to retire the targeted subsidies over time. This will not only disallow resource-hogging by incompetent entrepreneurs in the long run, but also distort the economy by less given the accordingly lower taxes. Our theory, however, is motivated by the near-permanence of entrenched preferential policy treatments in the real world, and we view the government's inability to remove them in the future as a constraint on its conduct of industrial policies.

6. Concluding remarks

Rather than summarize our findings here, we conclude with some implications of our work for the design of industrial policies.

In our framework, the long-run negative effect of industrial policies is a consequence of policymakers' inability to adjust over time and to target the most productive entrepreneurs each period. An obvious implication of our result is that a design attribute of industrial policies should be room for adjustment and re-optimization over time.[23] In a similar spirit, Rodrik (2008) argues that industrial policies should be thought of more as a *process* rather than a fixed set of *rules*. The question is how this is best achieved in practice. Rodrik argues that industrial policies should be "embedded" within society, meaning that the government should maintain ties to the private sector that serve the purpose of continually renegotiating policies while at the same time updating the required information.

An alternative is to use policy instruments that are contingent on the productivity of entrepreneurs in each period.[24] One example is provided by export promotion policies. These naturally target the most productive firms in any given period because only such firms will find it profitable to pay the fixed costs associated with exporting (Melitz, 2003).[25] The successful industrial policies of Asian miracle economies share this orientation toward export—see Leipziger (1997) and Chu (2000) and references therein.

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[22] An implication is that our theory of temporary booms followed by collapses is robust to policies not being perfectly persistent, provided that policies are persistent enough relative to productivity shocks.

[23] There is evidence that policymakers are mindful of the different degrees of adjustability of various policy instruments. For example, in the old debates on optimal subsidies versus tariffs, one main argument in support of subsidies was that it would be difficult to pay a subsidy longer than strictly necessary whereas a tariff may be more difficult to abolish (Bhagwati and Ramaswami, 1963).

[24] In our model, subsidies to the most productive producers are justified on efficiency grounds, because these producers tend to be constrained the most by financial frictions.

[25] One of the most common refrains against industrial policy is that governments cannot pick winners. In this sense, a subsidy contingent on exporting may be a way of automatically identifying most productive firms.

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