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Is there a role for governments in emerging countries to accelerate economic development by intervening in product and factor markets? To address this question, we study optimal dynamic Ramsey policies in a standard growth model with financial frictions. The optimal policy intervention involves pro-business policies like suppressed wages in early stages of the transition, resulting in higher entrepreneurial profits and faster wealth accumulation. This, in turn, relaxes borrowing constraints in the future, leading to higher labor productivity and wages. In the long run, optimal policy reverses sign and becomes pro-worker. In a multi-sector extension, optimal policy subsidizes sectors with a latent comparative advantage and, under certain circumstances, involves a depreciated real exchange rate. Our results provide an efficiency rationale, but also identify caveats, for many of the development policies actively pursued by dynamic emerging economies.

KEYWORDS: Industrial and development policies, Ramsey-optimal policies, collateral constraints, stage dependence, transition dynamics.

1. INTRODUCTION

IS THERE A ROLE for governments in emerging countries to accelerate economic development by intervening in product and factor markets? If so, which policies should they adopt? To answer these questions, we study optimal policy interventions in a standard growth model with financial frictions. In our framework, forward-looking heterogeneous producers face borrowing (collateral) constraints that result in capital misallocation and depressed productivity. This framework is, therefore, similar to the one commonly adopted in the macro-development literature to study the relationship between financial development and aggregate productivity (see, e.g., Banerjee and Duflo (2005), Song, Storesletten, and Zilibotti (2011), Buera and Shin (2013)). Our paper is the first to study the optimal Ramsey policies in such an environment along with their implications for a country's development dynamics.

Our main result is that the optimal policy involves interventions in both product and factor markets, yet the direction of these interventions is different for developing and developed countries, defined in terms of the level of their financial wealth relative to the steady state. In particular, in the initial phase of transition, when entrepreneurs are undercapitalized, optimal policies are *pro-business* in the sense of shifting resources to-

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wards entrepreneurs. Once the economy comes close enough to the steady state, where entrepreneurs are well capitalized, optimal policy switches to being *pro-worker*. Hence, optimal policy is *stage-dependent*.[1] In the case of the labor market, it is optimal to increase labor supply and suppress equilibrium wages in early stages of development, and restrict labor supply later on.[2] Greater labor supply and suppressed wages increase entrepreneurial profits and accelerate wealth accumulation. This, in turn, makes future financial constraints less binding, resulting in greater labor productivity and higher wages.

From a more positive perspective, we are motivated by the observation that many successful emerging economies pursue active development and industrial policies, and in particular, policies that appear to favor businesses. A widespread example of such policies is the suppression or subsidization of factor prices. For example, South Korea in the 1970s imposed an official upper limit on the growth of real wages,[3] and we discuss other examples at the end of this Introduction. From a neoclassical perspective, such policies are, of course, unambiguously detrimental. In this paper, we argue that some of these policies may instead be beneficial, particularly at early stages of development. Our result on the stage-dependence of optimal policies provides an efficiency rationale for the different labor market institutions adopted by emerging Asian and developed European countries, without relying on differences in preferences or political systems.

We tackle the design of optimal policy using a tractable workhorse macro-development model, which allows us to obtain sharp analytical characterizations. Our baseline economy is populated by two types of agents: a continuum of heterogeneous entrepreneurs and a continuum of representative workers. Entrepreneurs differ in their wealth and their productivity, and borrowing constraints limit the extent to which capital is reallocated from wealthy to productive individuals. In the presence of financial frictions, productive entrepreneurs make positive profits, and then optimally choose how much of these to consume and how much to retain for wealth accumulation. Workers decide how much labor to supply to the market and how much to save. Our baseline framework builds on Moll (2014) and makes use of the insight that heterogeneous agent economies remain tractable if individual production functions feature constant returns to scale.[4] Section 2 lays out the structure of the economy and characterizes the decentralized laissez-faire equilibrium. As a result of financial frictions, marginal products of capital are not equalized across agents, and constrained entrepreneurs obtain a higher rate of return than that available to workers. It is this differential in rates of return that is exploited by the policy interventions we consider.

In Section 3, we introduce various tax instruments into this economy and study the optimal Ramsey policies given the available set of instruments. We consider the problem of a benevolent planner subject to the same financial frictions present in the decentralized

[1] In "Optimal Development Policies: Lessons from Experience," Tinbergen (1984, p. 112) wrote: "'Development policy' was the name given to the new endeavours whose ideal was to raise the standard of living in the way best possible in the prevailing circumstances. [...] What is still needed is an optimal development policy within ever-changing surroundings." Our analysis of dynamic optimal development policies is an attempt to provide one possible answer to this call.

[2] This reduced labor supply and the resulting increase in wages are reminiscent of a *labor union* allocation.

[3] South Korea's Economic Planning Board directed firms to keep nominal wage growth below 80 percent of the sum of inflation and aggregate productivity growth, which resulted in real wage growth lagging behind productivity growth (see Kim and Topel (1995), Kim and Leipziger (1997)). Labor unions were also restricted. On the anecdotal side, President Park Chung Hee in his annual national address declared 1965 a "year to work," and twelve months later, he humorlessly named 1966 a "year of harder work" (Schuman (2010)).

[4] By adopting specific distributional assumptions, we gain additional tractability essential for our dynamic optimal policy analysis and the various extensions we consider later in the paper.

economy. We first consider the case with a subset of tax instruments, which effectively allow the planner to manipulate worker savings and labor supply decisions, and then show how the results generalize to cases with a much larger set of instruments, which in particular includes credit subsidies to firms (entrepreneurs). As already mentioned, the optimal policy intervention increases labor supply in the initial phase of transition, when entrepreneurs are undercapitalized, and reduces labor supply once the economy comes close enough to the steady state. We show in Section 3.3 that it remains optimal to distort labor supply in this fashion even when credit or capital subsidies are available, which are arguably more direct instruments for targeting the underlying inefficiency. Furthermore, in Section 3.4, we show that this policy remains optimal even when workers are finitely lived as in Blanchard (1985) and Yaari (1965), face borrowing constraints, and when the planner is present-biased in favor of current generations.

While our benchmark analysis focuses on a labor supply subsidy for concreteness, there are, of course, many equivalent ways of implementing the optimal allocation, including non-tax market regulation which is widespread in practice, as we discuss in Section 3. The common feature of optimal policies is that, in the short run, they make workers work more even though wages paid by firms are low. Perhaps surprisingly, we show that such *pro-business* development policies are optimal even when the planner puts zero weight on the welfare of entrepreneurs. Indeed, the planner finds it optimal to hurt workers in the short run so as to reward them with higher wages and shorter work hours in the medium and long run. An alternative way of thinking about this result is that the labor supply decision of workers involves a dynamic *pecuniary externality* (see Greenwald and Stiglitz (1986)): workers do not internalize the fact that working more leads to faster wealth accumulation by entrepreneurs and higher wages in the future. The planner corrects this using a Pigouvian subsidy.[5]

In order to obtain analytical results, we adopt a number of assumptions which allow for tractable aggregation of the economy and result in a simple characterization of equilibrium dynamics under various government policies. The most important among these are constant returns in production, i.i.d. productivity shocks drawn from an unbounded Pareto distribution, and no financial constraints on workers. In Section 4, to relax these assumptions, we give up analytical tractability and extend the model to a richer quantitative environment featuring a time-varying joint distribution of wealth and productivity as a state variable, making optimal policy analysis a challenging task at the computational frontier. This allows us to examine the robustness of our results as well as to gauge the quantitative importance of both the optimal and various suboptimal policies. We find that the optimal policies are stage-dependent as in our analytical results and can lead to considerable welfare improvements. Our quantitative results therefore confirm our main message that pro-business policies are especially important for growth at earlier stages of development, and that such policies can be welfare-improving even from workers' perspective.

In Section 5, we take advantage of the tractability of our framework and extend the model to multiple tradable and non-tradable sectors. This allows us to study the optimal industrial policies and address a number of popular policy issues, such as promotion of

[5]We show that a reduced form of our model is mathematically equivalent to a setup in which production is subject to a learning-by-doing externality, whereby working more today increases future productivity, as in Krugman (1987) and Young (1991). While reduced forms are similar, the economies are structurally different: the dynamic externality in our framework is a pecuniary one, stemming from the presence of financial frictions and operating via misallocation of resources, rather than a technological one.

comparative advantage sectors (see, e.g., Lin (2012)) and optimal exchange rate policy (see, e.g., Rodrik (2008)). We show, for example, that financial frictions create a wedge between the short-run and long-run (*latent*) comparative advantage of a country, and that the optimal policy tilts the allocation of resources towards the latent comparative advantage sectors, thereby speeding up the transition.[6] Next, we identify circumstances under which optimal policy involves a depreciated real exchange rate. Last, we develop an extension with overlapping cohorts of entrepreneurs and show that optimal policy requires age-dependent subsidies akin to the popular policy of *infant industry protection*.

Empirical Relevance. There exist a large number of historical accounts that the sort of pro-business policies prescribed by our normative analysis have been used in countries with successful development experiences. In a companion Supplemental Material Appendix B (Itskhoki and Moll (2019)), we discuss in detail development policies in seven East Asian countries that have experienced episodes of rapid growth: Japan, Korea, Taiwan, Malaysia, Singapore, Thailand, and China.[7] Typical policies include the suppression of wages and intermediate input prices. Another commonly observed policy is some form of subsidized credit to particular sectors or firms, often conditional on their export status. Many of these policies are reminiscent of the normative prescriptions in our theoretical analysis for economies in the early stages of development. In practice, such policies were frequently imposed for reasons other than development, for example, due to political, ideological, or rent-seeking considerations (see, e.g., Harrison and Rodríguez-Clare (2010)). Yet, our analysis suggests that successful growth episodes may have occurred not despite but, at least in part, due to the adoption of such policies.

From a more historical perspective, Feinstein (1998) and Voth (2001) provided evidence that the rapid economic growth in 18th-century Britain was in part due to reduced labor and land prices as well as long work hours. Ventura and Voth (2015) argued that this was caused by expanding government borrowing which crowded out unproductive agricultural investment and reduced factor demand by this declining sector. Lower factor prices, in turn, increased profits in the new industrial sectors, allowing the capitalists in these sectors to build up wealth, which in the absence of an efficient financial system was the major source of investment. This historical account resonates well with the mechanics of our model.

Related Literature. Our paper is related to the large theoretical literature studying the role of financial market imperfections in economic development, and in particular, the more recent literature relating financial frictions to aggregate productivity. We contribute to this literature by studying optimal Ramsey policies and the resulting implications for a country's transition dynamics in both a one-sector and a multi-sector environment.[8]

[6]Such policies have even been embraced by the World Bank: their Growth Commission (2008) report argues that export promotion policies may be beneficial, at least as long as they are only temporary.

[7]Appendix B is available at http://www.princeton.edu/~itskhoki/papers/FinFrictionsDevoPolicy_AppendixB.pdf.

[8]In addition to the papers cited in the beginning of the Introduction, see also Banerjee and Newman (1993), Galor and Zeira (1993), Aghion and Bolton (1997), Jeong and Townsend (2007), Erosa and Hidalgo-Cabrillana (2008), Caselli and Gennaioli (2013), Amaral and Quintin (2010), Buera, Kaboski, and Shin (2011), Midrigan and Xu (2014), and the recent surveys by Matsuyama (2008) and Townsend (2010). These papers are part of a growing literature exploring the macroeconomic effects of micro distortions (Restuccia and Rogerson (2008), Hsieh and Klenow (2009)). The modeling of financial frictions in the paper also follows the tradition in the recently burgeoning macro-finance literature (Kiyotaki and Moore (1997), Brunnermeier, Eisenbach, and Sannikov (2013)). A few papers in this literature evaluate the effects of various policies, including Banerjee and Newman (2003), Buera, Moll, and Shin (2013), Buera and Nicolini (2017), and Buera, Kaboski, and Shin (2012), but none study Ramsey-optimal policies. There is an even larger *empirical* literature showing the importance of finance for development (see Levine (2005) for a survey).

In related work, Caballero and Lorenzoni (2014) analyzed the Ramsey-optimal response to a cyclical demand shock in a two-sector small open economy with financial frictions in the tradable sector. In both papers, financial frictions give rise to a pecuniary externality, which justifies a policy intervention that distorts the allocation of resources across sectors. But the focus of the two papers is different: ours studies long-run development policies, whereas theirs studies cyclical policies.[9] Another closely related paper is Song, Storesletten, and Zilibotti (2014), who studied the effects of capital controls and policies regulating interest rates and the exchange rate. Their positive analysis shows that, in China, such policy interventions may have compressed wages and increased the wealth of entrepreneurs, relaxing the borrowing constraints of private firms, just like in our framework. Relative to their paper, our normative analysis shows that policies leading to compressed wages not only foster productivity growth but may, in fact, be *optimal* in the sense of maximizing welfare.

The general idea that different policies may be appropriate at different stages of a country's development has previously been explored by Acemoglu, Aghion, and Zilibotti (2006). They argued that countries far behind the frontier should adopt investment subsidies and other policies that increase firm profits and then, as they get closer to the frontier, switch to policies supporting innovation and selection. In their framework, the rationale for such policies is a Schumpeterian appropriability effect. In our framework, in contrast, the laissez-faire equilibrium is suboptimal due to the presence of financial frictions.

In terms of methodology, we follow the dynamic public finance literature and study a Ramsey problem (see, e.g., Barro (1979), Lucas and Stokey (1983)). The environment we study is similar to Judd (1985) and Straub and Werning (2014) in that it features a distributional conflict between capitalists and workers, but with the difference that capitalists are heterogeneous and face financial frictions and incomplete markets.[10] Our work differs from the classical Ramsey taxation literature in that we study optimal policy intervention in the presence of financial frictions, rather than the optimal financing of an exogenously given stream of government expenditure or optimal debt management.

2. AN ECONOMY WITH FINANCIAL FRICTIONS

In this section, we describe our baseline one-sector small open economy. We extend our analysis to a closed economy in Appendix A4 of the Supplemental Material (Itskhoki and Moll (2019)) and to a multi-sector economy with tradable and non-tradable sectors in Section 5.[11] Our goal is to develop a model of transition dynamics with financial frictions in which we can analyze optimal government interventions. This goal motivates adopting a number of assumptions which allow for tractable aggregation of the economy and result in a simple characterization of equilibrium dynamics under various government policies. We later relax many of these assumptions in Section 4.

[9] See also Angeletos, Collard, Dellas, and Diba (2013) and Bacchetta, Benhima, and Kalantzis (2014) for related Ramsey problems and Michelacci and Quadrini (2009) for a related study of optimal long-term contracts between employers and employees. A related strand of work emphasizes a different type of pecuniary externality that operates through prices in borrowing constraints (see, e.g., Lorenzoni (2008), Jeanne and Korinek (2010), Bianchi (2011)). Yet another type of pecuniary externality was analyzed in the earlier work on the "big push" (e.g., see Murphy, Shleifer, and Vishny (1989)).

[10] See Aiyagari (1995) and Shin (2006) for related analyses of Ramsey problems in environments with idiosyncratic risk and incomplete markets, but without collateral constraints.

[11] Appendix A contains additional extensions, as well as detailed derivations and proofs for the baseline analysis, and can be found at http://www.princeton.edu/~itskhoki/papers/FinFrictionsDevoPolicy_AppendixA.pdf.

The economy is set in continuous time with an infinite horizon and no aggregate shocks, so as to focus our analysis on the properties of the transition paths. There are two types of agents—workers and entrepreneurs—and we start by describing their problems in turn. We then characterize the aggregate relationships and properties of the decentralized equilibrium.

2.1. *Workers and Entrepreneurs*

A representative worker (household) in the economy has preferences given by

$$\int_0^\infty e^{-\rho t} u\big(c(t), \ell(t)\big)\, \mathrm{d}t, \tag{1}$$

where ρ is the discount rate, c is consumption, and ℓ is market labor supply. We assume that $u(\cdot)$ is increasing and concave in its first argument and decreasing and convex in its second argument, with a positive and finite Frisch elasticity of labor supply (see Appendix A1.1). Where it leads to no confusion, we drop the time index t.

Households take the market wage $w(t)$ as given as well as the price of the consumption good, which we choose as the numeraire. They borrow and save using non-state-contingent bonds, which pay the risk-free interest rate $r(t) \equiv r^*$, and hence face the flow budget constraint

$$c + \dot{b} \leq w\ell + r^* b, \tag{2}$$

where $b(t)$ is the household asset position. The solution to the household problem satisfies a standard Euler equation and a static optimality (labor supply) condition. In Section 3.4, we extend our analysis to an environment with overlapping generations of finitely-lived households that also face borrowing constraints.

The economy is also populated by a unit mass of entrepreneurs who produce the homogeneous tradable good. Entrepreneurs are heterogeneous in their wealth a and productivity z, and we denote their joint distribution at time t by $\mathcal{G}_t(a, z)$. In each time period of length Δt, entrepreneurs draw a new productivity from a Pareto distribution $G_z(z) = 1 - z^{-\eta}$ with shape parameter $\eta > 1$, where a smaller η corresponds to a greater heterogeneity of the productivity draws. We consider the limit economy in which $\Delta t \to 0$, so we have a continuous-time setting in which productivity shocks are i.i.d. over time.[12] Appendix A4.1 generalizes our *qualitative* results to an environment with a persistent productivity process, while Section 4 considers a *quantitative* version of the model with decreasing returns to scale and a diffusion process for idiosyncratic productivities, which render the model analytically intractable.

Entrepreneurs have preferences

$$\mathbb{E}_0 \int_0^\infty e^{-\delta t} \log c_e(t)\, \mathrm{d}t, \tag{3}$$

where δ is their discount rate. Each entrepreneur owns a private technology which can combine k units of capital and n units of labor to produce

$$A(zk)^\alpha n^{1-\alpha} \tag{4}$$

[12] Moll (2014) showed that an i.i.d. process in continuous time can be obtained by considering a limit of a mean-reverting process as the speed of mean reversion goes to infinity. In addition, we assume a law of large numbers so the share of entrepreneurs experiencing any particular sequence of shocks is deterministic.

units of output, where $\alpha \in (0,1)$, and A is aggregate productivity, which could potentially follow an exogenous time path. Entrepreneurs hire labor in a competitive labor market at wage $w(t)$ and hire capital in a capital rental market at rental rate $r(t) \equiv r^*$.

Entrepreneurs face collateral constraints:

$$k \leq \lambda a, \tag{5}$$

where $\lambda \geq 1$ is an exogenous parameter, which captures the degree of financial development, from self-financing when $\lambda = 1$ to perfect capital markets as $\lambda \to \infty$. By placing a restriction on an entrepreneur's leverage ratio k/a, the constraint captures the common prediction from models of limited commitment that the amount of capital available to an entrepreneur is limited by her personal wealth and that production requires a certain minimum *skin in the game*. Banerjee and Duflo (2005) surveyed evidence on the importance of such constraints for developing countries. The particular formulation of the constraint in (5) is analytically convenient and allows us to derive results in closed form.[13]

An entrepreneur's wealth evolves according to

$$\dot{a} = \pi(a,z) + r^* a - c_e, \tag{6}$$

where $\pi(a,z)$ are her profits

$$\pi(a,z) \equiv \max_{\substack{n \geq 0, \\ 0 \leq k \leq \lambda a}} \left\{ A(zk)^\alpha n^{1-\alpha} - wn - r^* k \right\}. \tag{7}$$

Maximizing out the choice of labor n, profits are linear in capital k. It follows that the optimal capital choice is at a corner: it is zero for entrepreneurs with low productivity, and the maximal amount allowed by the collateral constraints, λa, for those with high enough productivity. We assume that along all transition paths considered, there always exist entrepreneurs with productivity low enough that they choose to be inactive. In this case, the solution to (7) admits the following characterization (see Appendix A1.2):

LEMMA 1: *Factor demands and profits are linear in wealth and can be written as*

$$k(a,z) = \lambda a \cdot \mathbf{1}_{\{z \geq \underline{z}\}}, \tag{8}$$

$$n(a,z) = \left[(1-\alpha)A/w\right]^{1/\alpha} z k(a,z), \tag{9}$$

$$\pi(a,z) = \left[\frac{z}{\underline{z}} - 1\right] r^* k(a,z), \tag{10}$$

[13] Following the literature, we model financial frictions as the interaction between incomplete markets and collateral constraints, both exogenously imposed. The constraint can be derived from a limited commitment problem, in which an entrepreneur can steal a fraction $1/\lambda$ of rented capital k, and lose her wealth a as a punishment (see Kiyotaki and Moore (1997), Banerjee and Newman (2003), Buera and Shin (2013)). As shown in Moll (2014), the constraint could be generalized in a number of ways at the expense of some extra notation. In particular, the maximum leverage ratio λ can depend on the interest rate, wages, and other aggregate variables, or evolve over time. In addition, the financing friction may also extend to working capital needed to cover an entrepreneur's wage bill. What *is* crucial is that the collateral constraint (5) is linear in wealth and static (ruling out dynamic incentive contracts as, e.g., in Kehoe and Levine (2001)). Di Tella and Sannikov (2016) provided a microfoundation to such constraints in a dynamic environment with hidden savings.

where the productivity cutoff $\underline{z}$ satisfies

$$\alpha\left(\frac{1-\alpha}{w}\right)^{\frac{1-\alpha}{\alpha}} A^{1/\alpha}\underline{z} = r^*. \tag{11}$$

Marginal entrepreneurs with productivity $\underline{z}$ break even and make zero profits, while entrepreneurs with productivity $z > \underline{z}$ receive Ricardian rents given by (10), which depend on both their productivity edge and the scale of operation determined by their wealth through the collateral constraint. Entrepreneurs' labor demand depends on both their productivity and their capital choice, with marginal products of labor equalized across active entrepreneurs. At the same time, the choice of capital among active entrepreneurs is shaped by the collateral constraint, which depends only on their assets and not on their productivity. Therefore, entrepreneurs with higher productivity z have a higher marginal product of capital, reflecting the misallocation of resources in the economy. The corner solution for the choice of capital in (8) is a consequence of the constant returns to scale assumption, which we relax in Section 4.

Finally, entrepreneurs choose consumption and savings to maximize (3) subject to (6) and (10). Under our assumption of log utility, combined with the linearity of profits in wealth, there exists an analytic solution to their consumption policy function, $c_e = \delta a$, and therefore the evolution of entrepreneurs' wealth satisfies (see Appendix A1.3)

$$\dot{a} = \pi(a, z) + \big(r^* - \delta\big)a. \tag{12}$$

This completes our description of workers' and entrepreneurs' individual behavior.

2.2. *Aggregation and Equilibrium*

We start by describing a number of useful equilibrium relationships. Aggregating (8) and (9) over all entrepreneurs, we obtain the aggregate capital and labor demand:

$$\kappa = \lambda x \underline{z}^{-\eta}, \tag{13}$$

$$\ell = \frac{\eta}{\eta - 1}\big[(1-\alpha)A/w\big]^{1/\alpha}\lambda x \underline{z}^{1-\eta}, \tag{14}$$

where $x(t) \equiv \int a \, \mathrm{d}\mathcal{G}_t(a, z)$ is aggregate entrepreneurial wealth.[14] Note that we have made use of the assumption that productivity shocks are i.i.d. over time, which implies that, at each point in time, wealth a and productivity z are independent in the cross-section of entrepreneurs. Intuitively, the aggregate demand for capital in (13) equals the aggregate leveraged wealth of the entrepreneurs λx times the fraction of active entrepreneurs $\underline{z}^{-\eta} = \mathbb{P}\{z \geq \underline{z}\}$, as follows from the Pareto productivity distribution.

Aggregate output in the economy can be characterized by a production function:

$$y = Z\kappa^{\alpha}\ell^{1-\alpha} \quad \text{with } Z \equiv A\left(\frac{\eta}{\eta - 1}\underline{z}\right)^{\alpha}, \tag{15}$$

[14] Specifically, $\kappa(t) = \int k_t(a, z) \, \mathrm{d}\mathcal{G}_t(a, z)$ and $\ell(t) = \int n_t(a, z) \, \mathrm{d}\mathcal{G}_t(a, z)$. Below, aggregate output in (15) equals $y(t) = \int A(t)(z k_t(a, z))^{\alpha} n_t(a, z)^{1-\alpha} \, \mathrm{d}\mathcal{G}_t(a, z)$, integrating individual outputs in (4), and expressing it in terms of aggregate capital and labor, $\kappa(t)$ and $\ell(t)$. See derivations in Appendix A1.2.

where Z is the endogenous aggregate total factor productivity (TFP), which is a product of aggregate technology A and the average productivity of active entrepreneurs, $\mathbb{E}\{z|z \geq \underline{z}\} = \frac{\eta}{\eta-1}\underline{z}$. Imposing labor market clearing, and using the aggregation results in (13)–(15) together with the productivity cutoff condition (11), we can characterize the equilibrium relationships in the frictional economy (see Appendix A1.2):

LEMMA 2: (a) *Equilibrium aggregate output satisfies*

$$y = y(x, \ell) \equiv \Theta x^{\gamma} \ell^{1-\gamma}, \quad \text{where } \Theta \equiv \frac{r^*}{\alpha}\left[\frac{\eta\lambda}{\eta-1}\left(\frac{\alpha A}{r^*}\right)^{\eta/\alpha}\right]^{\gamma} \text{ and } \gamma \equiv \frac{\alpha/\eta}{\alpha/\eta + (1-\alpha)}. \tag{16}$$

(b) *The productivity cutoff $\underline{z}$ is given by*

$$\underline{z}^{\eta} = \frac{\eta\lambda}{\eta-1}\frac{r^*}{\alpha}\frac{x}{y}, \tag{17}$$

while aggregate income y is split between factors as follows:

$$w\ell = (1-\alpha)y, \qquad r^*\kappa = \alpha\frac{\eta-1}{\eta}y \quad \text{and} \quad \Pi = \frac{\alpha}{\eta}y, \tag{18}$$

where $\Pi(t) \equiv \int \pi_t(a, z)\, \mathrm{d}\mathcal{G}_t(a, z)$ is aggregate entrepreneurial income (profits).

The first part of Lemma 2 expresses equilibrium aggregates as functions of entrepreneurial wealth x and labor supply ℓ. In contrast to a neoclassical world, entrepreneurial wealth is essential for production in a frictional environment, and it affects aggregate output with elasticity γ. Parameter γ increases in capital intensity α and in the heterogeneity of entrepreneurs' productivity (decreases in η), capturing the extent of entrepreneurial rents, $\Pi = \frac{\alpha}{\eta}y$ in (18). Therefore, γ is a measure of distance from the frictionless limit, and it plays an important role in the analysis of optimal policies in Section 3. Also note that the derived aggregate productivity Θ is equally shaped by the primitive productivity A and the financial constraint λ, which together govern endogenous TFP.

Given aggregate production in (16), both the equilibrium wage rate $w = (1-\alpha)y/\ell$ and the productivity cutoff $\underline{z}$ in (17) are increasing functions of x/ℓ. High entrepreneurial wealth x increases capital demand and allows a given labor supply to be absorbed by a smaller subset of more productive entrepreneurs. This raises both the average productivity of active entrepreneurs and aggregate labor productivity (hence wages). If labor supply ℓ increases, less productive entrepreneurs need to become active to absorb it, which in turn reduces average productivity and wages. Note that the tractable functional forms in the expressions of the lemma are due to the Pareto productivity assumption.

The second half of Lemma 2 characterizes the split of aggregate income y in the economy with financial frictions. The share of labor equals $(1-\alpha)$, as in the frictionless world, since the choice of labor is unconstrained. However, the presence of financial frictions results in active entrepreneurs making positive profits, $\Pi > 0$, in contrast with the neoclassical limit, where $\Pi = 0$. Hence, a fraction of national income is received by entrepreneurs at the expense of rentiers, whose share of income, $r^*\kappa/y$, falls below α. This is a result of the depressed demand for capital in a frictional environment, despite the maintained rate of return on capital r^*. Nonetheless, incomes of all groups in the economy—workers,

entrepreneurs, and rentiers—increase in aggregate output y, which is itself an increasing function of both entrepreneurial wealth x and labor supply ℓ.

Finally, integrating (12) across all entrepreneurs, aggregate entrepreneurial wealth evolves according to

$$\dot{x} = \frac{\alpha}{\eta} y(x, \ell) + \big(r^* - \delta\big)x, \tag{19}$$

where, by (18), the first term on the right-hand side equals aggregate entrepreneurial profits Π. Therefore, greater labor supply increases output, which raises entrepreneurial profits and speeds up wealth accumulation, which in future periods leads to higher labor productivity y/ℓ by raising the cutoff productivity level $\underline{z}$, according to Lemma 2.

A *competitive equilibrium* in this small open economy is defined in the usual way. Workers and entrepreneurs solve their respective problems taking prices as given, while the path of wages clears the labor market at each point in time and capital is in perfectly elastic supply at interest rate r^*. Equilibrium can be summarized as a time path for aggregate variables $\{c, \ell, b, y, x, w, \underline{z}\}_{t\geq 0}$ satisfying (2), standard household optimality, and (16)–(19), given an initial household asset position b_0, initial entrepreneurial wealth x_0, and a path of exogenous productivity A. Actions of individual entrepreneurs can then be recovered from (8)–(10) and (12). This tractable characterization of the transition dynamics in our heterogeneous agent model is what allows for the closed-form optimal policy analysis in Section 3.[15]

2.3. *Inefficiency: The Return Wedge*

The key to understanding the rationale for policy intervention in our economy is that entrepreneurs earn an excess return relative to workers. Indeed, workers face a rate of r^*, while an entrepreneur with productivity z generates a return $R(z) \equiv r^*\big(1 + \lambda[\frac{z}{\underline{z}} - 1]^+\big) \geq r^*$, with $R(z) > r^*$ for $z > \underline{z}$. Because of the collateral constraint, an entrepreneur with productivity $z > \underline{z}$ cannot expand her capital to drive down her return towards r^*. Similarly, not only individual entrepreneurs but also entrepreneurs *as a group* earn an excess return. In particular, the average rate of return across entrepreneurs is given by

$$\mathbb{E}_z R(z) = r^*\left(1 + \frac{\lambda \underline{z}^{-\eta}}{\eta - 1}\right) = r^* + \frac{\alpha}{\eta}\frac{y}{x} > r^*, \tag{20}$$

where the first equality integrates $R(z)$ using the Pareto distribution $G_z(z)$ and the second equality uses the equilibrium cutoff expression (17).

Given that workers and entrepreneurs face different rates of return, which fail to equalize due to the financial friction, a Pareto improvement can be achieved by a wealth transfer from workers to all entrepreneurs (independently of their productivity) combined with a reverse transfer at a later point in time.[16] This perturbation sharply illustrates the na-

[15] Some of our results could be illustrated in an economy without heterogeneity, with a single productivity type. A model with heterogeneity is, however, closer to the canonical framework used in the macro-development literature, and it allows us to study the effects on misallocation and TFP. Furthermore, and perhaps surprisingly, the presence of a continuum of heterogeneous entrepreneurs gives greater tractability to the model, by summarizing the effects of financial frictions via a single endogenously-evolving productivity cutoff $\underline{z}$.

[16] More precisely, we show in Appendix A2 that any transfer of resources from workers to entrepreneurs at $t = 0$ and a reverse transfer at $t' > 0$ with interest accumulated at a rate $r_\omega = r^* + \omega \int_0^{t'} \frac{\alpha}{\eta}\frac{y(t)}{x(t)}\,\mathrm{d}t > r^*$ for some $\omega \in (0, 1)$ would necessarily lead to a strict Pareto improvement for all workers and entrepreneurs.

ture of the inefficiency in the laissez-faire equilibrium and provides a natural benchmark for thinking about various other policy interventions. Yet such transfers may not be a realistic policy option. For example, large transfers to entrepreneurs may be infeasible for budgetary, distributional, or political economy reasons, or due to the associated informational frictions and informational requirements to administer them (see further discussion in Appendix A2.3).

Furthermore, the type of transfer policy discussed here effectively allows the government to get around the specific financial constraint we have adopted, and hence it is not particularly surprising that it results in a Pareto improvement. Such a transfer policy may also not prove robust to alternative formulations of the financial friction. It is for these reasons that the main focus of the paper is on Ramsey-optimal taxation with a given set of simple policy tools. While also having the capacity to Pareto-improve upon the laissez-faire allocation, the policy tools we study in the next section constitute a more realistic and, we think, more robust alternative to transfers.

3. OPTIMAL POLICY IN A ONE-SECTOR ECONOMY

In this section, we study optimal Ramsey interventions with a given set of policy tools. We start our analysis with two tax instruments—a labor income tax and a savings tax—operating directly on the decision margins of the households. In Section 3.3, we generalize our results to an environment which allows for additional tax instruments directly affecting the decisions of entrepreneurs, including a credit subsidy.

3.1. *Economy With Taxes*

In the presence of labor income and savings taxes on workers, $\tau_\ell(t)$ and $\tau_b(t)$, the budget constraint of the households changes from (2) to

$$c + \dot{b} \leq (1 - \tau_\ell) w\ell + \big(r^* - \tau_b\big)b + T, \tag{21}$$

where T are the lump-sum transfers from the government (lump-sum taxes if negative). In our framework, Ricardian equivalence applies, and only the combined wealth of households and the government matters. Therefore, without loss of generality, we assume that the government budget constraint is balanced period by period:

$$T = \tau_\ell w\ell + \tau_b b. \tag{22}$$

More generally, if the government can run a budget deficit and issue debt, we can guarantee implementation of the Ramsey policies without lump-sum taxes.[17]

In the presence of taxes, the optimality conditions of households become

$$\dot{u}_c/u_c = \rho - r^* + \tau_b, \tag{23}$$

$$-u_\ell/u_c = (1 - \tau_\ell)w, \tag{24}$$

while the wage rate w still satisfies the labor demand relationship (18).

The following result simplifies considerably the analysis of the optimal policies:

[17]As we show below, in the long run, $\tau_b = 0$ and $\tau_\ell > 0$, so that the government can roll forward the debt it has accumulated in the short run without violating the intertemporal budget constraint. This can be achieved either without any lump-sum taxes or transfers, $T \equiv 0$, or only with lump-sum transfers to households, $T \geq 0$, in case the government runs a gross budget surplus in the long run.

LEMMA 3: *Any aggregate allocation* $\{c, \ell, b, x\}_{t\geq 0}$ *satisfying*

$$c + \dot{b} = (1-\alpha)y(x,\ell) + r^* b, \tag{25}$$

$$\dot{x} = \frac{\alpha}{\eta} y(x,\ell) + \big(r^* - \delta\big)x, \tag{26}$$

where $y(x,\ell)$ *is defined in* (16), *can be supported as a competitive equilibrium under appropriately chosen policies* $\{\tau_\ell, \tau_b, T\}_{t\geq 0}$, *and the equilibrium characterization in Lemma* 2 *applies*.

Intuitively, equations (25) and (26) are respectively the aggregate budget constraints of workers and entrepreneurs, where we have substituted the government budget constraint (22) and the allocation of aggregate income $y(x,\ell)$ from Lemma 2. Lemma 2 still holds in this environment because it only relies on labor market clearing and policy functions of the entrepreneurs, which are not affected by the introduced policy instruments. The additional two constraints on the equilibrium allocation are the optimality conditions of workers, (23) and (24), but they can always be ensured to hold by an appropriate choice of labor and savings subsidies for workers, τ_ℓ and τ_b. Finally, given a dynamic path of ℓ and x, we can recover all remaining aggregate variables supporting the allocation from Lemma 2.

Similarly to the *primal approach* in the Ramsey taxation literature (e.g., Lucas and Stokey (1983)), Lemma 3 allows us to replace the problem of choosing a time path of the policy instruments in a decentralized dynamic economy by a simpler problem of choosing a dynamic aggregate allocation satisfying the *implementability constraints* (25) and (26). These two constraints differ somewhat from those one would obtain following the standard procedure of the primal approach because we exploit the special structure of our model (summarized in Lemma 2) to derive more tractable conditions.

3.2. *Optimal Ramsey Policies*

We assume for now that the planner maximizes the welfare of households and puts zero weight on the welfare of entrepreneurs. As will become clear, this is the most conservative benchmark for our results. The Ramsey problem in this case is to choose policies $\{\tau_\ell, \tau_b, T\}_{t\geq 0}$ to maximize household utility (1) subject to the resulting allocation being a competitive equilibrium. From Lemma 3, this problem is equivalent to maximizing (1) with respect to the aggregate allocation $\{c, \ell, b, x\}_{t\geq 0}$ subject to (25)–(26), which we rewrite as

$$\begin{aligned} \max_{\{c,\ell,b,x\}_{t\geq 0}} & \int_0^\infty e^{-\rho t} u(c,\ell)\,\mathrm{d}t \\ \text{subject to} \quad & c + \dot{b} = (1-\alpha)y(x,\ell) + r^* b, \\ & \dot{x} = \frac{\alpha}{\eta} y(x,\ell) + \big(r^* - \delta\big)x, \end{aligned} \tag{P1}$$

and given initial conditions b_0 and x_0. Equation (P1) is a standard optimal control problem with controls (c,ℓ) and states (b,x), and we denote the corresponding co-state vector

by $(\mu, \mu\nu)$. To ensure the existence of a finite steady state, we assume $\delta > \rho = r^*$, which, however, is *not* essential for the pattern of optimal policies along the transition path.[18]

Before characterizing the solution to (P1), we provide a brief discussion of the nature of this planner's problem. Apart from the Ramsey-problem interpretation that we adopt here, this planner's problem admits two additional interpretations. First, it corresponds to the planner's problem adopted in Caballero and Lorenzoni (2014), which rules out any transfers or direct interventions into the decisions of agents, and only allows for aggregate market interventions which affect agent behavior by moving equilibrium prices (wages in our case). Second, the solution to this planner's problem is a constrained-efficient allocation under the definition developed in Dávila, Hong, Krusell, and Ríos-Rull (2012) for economies with exogenously incomplete markets and borrowing limits, as ours, where standard notions of constrained efficiency are hard to apply. Under this definition, the planner can choose policy functions for all agents respecting, however, their budget sets and exogenous borrowing constraints. Indeed, in our case, the planner does not want to change the policy functions of entrepreneurs, but chooses to manipulate the policy functions of households exactly in the way prescribed by the solution to (P1). The implication is that the planner in this case does not need to separate workers and entrepreneurs, relaxing the informational requirement of the Ramsey policy. As we show in later sections, the baseline structure of the planner's problem (P1) is maintained in a number of extensions we consider.

The optimality conditions for the planner's problem (P1) are given by (see Appendix A3.1)

$$\frac{\dot{u}_c}{u_c} = \rho - r^* = 0, \tag{27}$$

$$-\frac{u_\ell}{u_c} = (1 - \gamma + \gamma\nu) \cdot (1 - \alpha)\frac{y}{\ell}, \tag{28}$$

$$\dot{\nu} = \delta\nu - (1 - \gamma + \gamma\nu)\frac{\alpha}{\eta}\frac{y}{x}. \tag{29}$$

An immediate implication of (27) is that the planner does not distort the intertemporal margin, that is, $\tau_b \equiv 0$, as follows from (23). There is no need to distort the workers' saving decision since, holding labor supply constant, consumption does not have a direct effect on output $y(x, \ell)$ and hence on wealth accumulation in (26).[19]

In contrast, the laissez-faire allocation of labor, which satisfies (24) with $\tau_\ell \equiv 0$, is in general suboptimal. Indeed, combining the planner's optimality condition (28) with (18) and (24), the *labor wedge* (tax) can be expressed in terms of the co-state $\nu \geq 0$ as

$$\tau_\ell = \gamma(1 - \nu), \tag{30}$$

and whether labor supply is subsidized or taxed depends on whether ν is greater than 1.

Indeed, the planner has two reasons to distort the choice of labor supply, ℓ. First, workers take wages as given and do not internalize that $w = (1 - \alpha)y/\ell$ (see Lemma 2); that

[18]This assumption is not needed if workers are hand-to-mouth in equilibrium or subject to idiosyncratic income risk, in which case $\delta = \rho > r^*$ is a natural assumption in a small open economy and would also arise endogenously in a closed economy (Aiyagari (1994)).

[19]In a closed economy, in addition to intervening in the labor market, the planner also chooses to distort the intertemporal savings margin to encourage a faster accumulation of capital (see Appendix A4.3).

is, by restricting labor supply, workers can increase their wages. As the planner only cares about the welfare of workers, this *monopoly effect* induces the planner to reduce labor supply. The statically optimal monopolistic labor tax equals γ in our model, and corresponds to the first term in brackets in (30).

Second, workers do not internalize the positive effect of their labor supply on entrepreneurial profits and wealth accumulation, which affects future output and wages. This *dynamic productivity effect* through wealth accumulation forces the planner to increase labor supply, and it is reflected in the second term in (30), $-\gamma\nu$. When entrepreneurial wealth is scarce, its shadow value for the planner is high ($\nu > 1$), and the planner increases labor supply, $\tau_\ell < 0$.[20] Otherwise, the static consideration dominates, and the planner reduces (taxes) labor supply. Finally, recall that γ is a measure of the distortion arising from the financial frictions, and, in the frictionless limit with $\gamma \to 0$, the planner does not need to distort any margin.

The planner's optimal allocation $\{c, \ell, b, x\}_{t\geq 0}$ solves the dynamic system (25)–(29). With $r^* = \rho$, the marginal utility of consumption is constant over time, $u_c(t) \equiv \bar{\mu}$, and the system separates in a convenient way. Given a level of $\bar{\mu}$, which can be pinned down from the intertemporal budget constraint, the optimal labor wedge $\tau_\ell = \gamma(1-\nu)$ can be characterized by means of two ODEs in (x, ν), (26) and (29), together with the static optimality condition (28). These can be analyzed by means of a phase diagram (Figure 1) and other standard tools (see Appendix A3.2) to yield the following:

PROPOSITION 1: *The solution to the planner's problem* (P1) *corresponds to the saddle path of the ODE system* (26) *and* (29), *as summarized in Figure* 1. *In particular, starting from* $x_0 < \bar{x}$, *both* $x(t)$ *and* $\tau_\ell(t) = \gamma(1-\nu(t))$ *increase over time towards the unique positive and globally stable steady state* $(\bar{\tau}_\ell, \bar{x})$, *with labor supply taxed in steady state*:

$$\bar{\tau}_\ell = \frac{\gamma}{\gamma + (1-\gamma)(\delta/\rho)} > 0. \tag{31}$$

Labor supply is subsidized, $\tau_\ell(t) < 0$, *when entrepreneurial wealth* $x(t)$ *is low enough. The planner does not distort the workers' intertemporal margin,* $\tau_b(t) \equiv 0$.

The optimal steady-state labor wedge is strictly positive, meaning that, in the long run, the planner suppresses labor supply rather than subsidizing it. This tax is, however, smaller than the optimal *monopoly tax* equal to γ (i.e., $0 < \bar{\tau}_\ell < \gamma$), because, with $\delta > r^*$, entrepreneurial wealth accumulation is bounded and the financial friction is never resolved (i.e., even in steady state, the shadow value of entrepreneurial wealth is positive, $\bar{\nu} > 0$). Nonetheless, in steady state, the redistributive force necessarily dominates dynamic productivity considerations. This, however, is not the case along the entire transition path, as we prove in Proposition 1 and illustrate in Figure 1. Consider a country that starts out with entrepreneurial wealth considerably below its steady-state level, that is, in which entrepreneurs are initially severely undercapitalized. Such a country finds it optimal to increase (subsidize) labor supply during the initial transition phase, until entrepreneurial wealth reaches a high enough level.

Figures 2 and 3 illustrate the transition dynamics for key variables, comparing the allocation chosen by the planner to the one that would obtain in a laissez-faire equilibrium.[21]

[20] Solving (29) forward, ν can be expressed as a net present value of future marginal products of wealth, $\partial y/\partial x = \gamma y/x$, which are monotonically decreasing in x, with $\lim_{x\to 0} \partial y/\partial x = \infty$ (see Appendix A3.2).

[21] Our numerical examples use balanced growth preferences with a constant Frisch elasticity $1/\varphi$, $u(c, \ell) = \log c - \psi \ell^{1+\varphi}/(1+\varphi)$, and the following benchmark parameter values: $\alpha = 1/3$, $\delta = 0.1$, $\rho = 0.03$, $\eta = 1.06$,

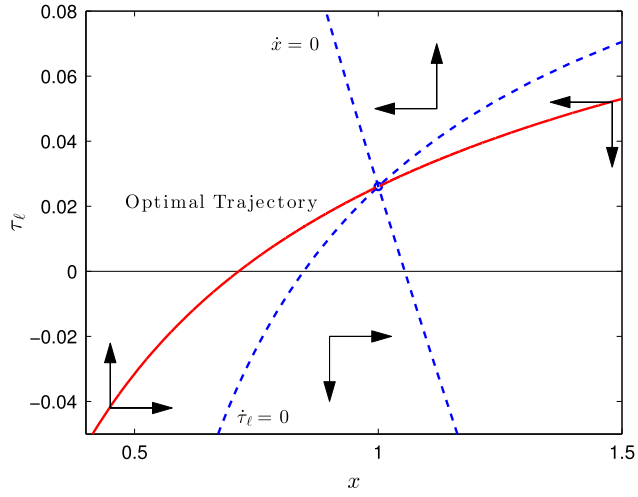

FIGURE 1.—Planner's allocation: phase diagram for transition dynamics.

The left panel of Figure 2 plots the optimal labor tax, which is negative in the early phase of the transition (i.e., a labor supply subsidy), and then switches to being positive in the long run. This is reflected in the initially increased and eventually depressed labor supply in the planner's allocation in Figure 3(a). The purpose of the labor supply subsidy is to speed up entrepreneurial wealth accumulation (Figures 2(b) and 3(b)), which in turn translates into higher productivity and wages in the medium run, at the cost of their reduction in the short run (Figures 3(c) and 3(d)). The labor tax and suppressed labor supply in the long run are used to redistribute the welfare gains from entrepreneurs towards workers through the resulting increase in wages.[22]

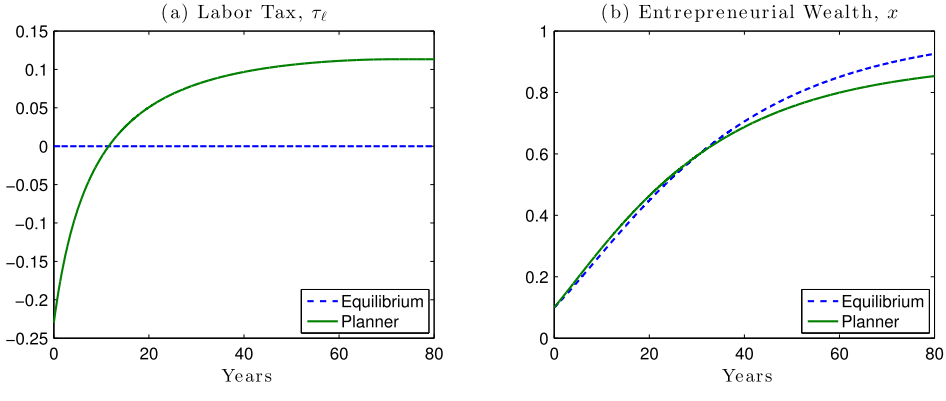

FIGURE 2.—Planner's allocation: labor tax $\tau_\ell(t)$ and entrepreneurial wealth $x(t)$. Note: In panel (b), the steady-state entrepreneurial wealth in the laissez-faire equilibrium is normalized to 1.

$\lambda = 2$, $\psi = 1$ and $\varphi = 1$. The initial condition x_0 is 10% of the steady-state level in the laissez-faire equilibrium, and the initial wealth of workers is $b_0 = 0$.

[22]Interestingly, even if the reversal of the labor subsidy were ruled out (by imposing a restriction $\tau_\ell \leq 0$), the planner still wants to subsidize labor during the early transition, emphasizing that the purpose of this policy is not merely a reverse redistribution at a later date. The same is true in an alternative model where financially-constrained firms are collectively owned by workers, and hence there is no distributional conflict.

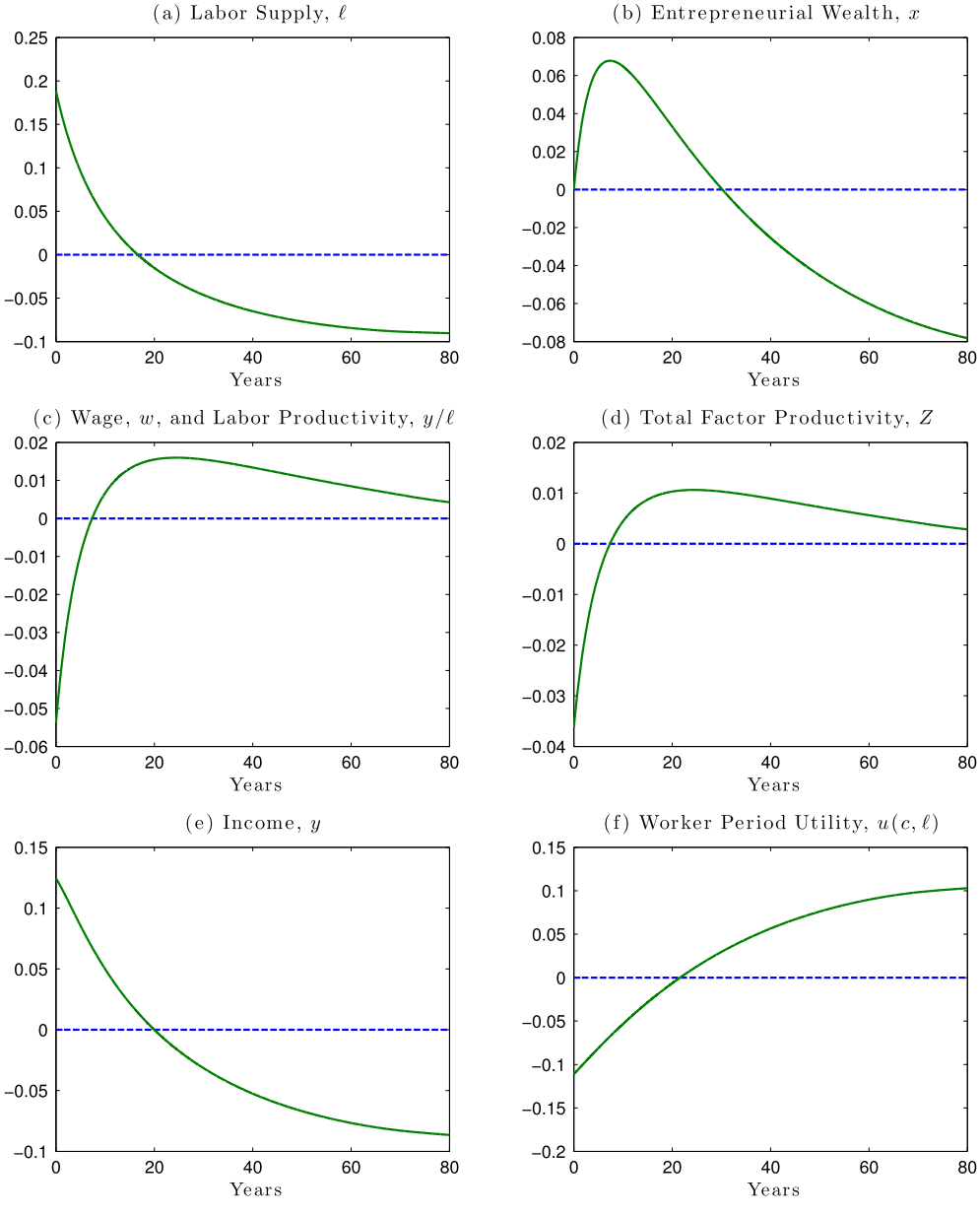

FIGURE 3.—Planner's allocation: proportional deviations from the laissez-faire equilibrium. Note: In panel (d), the deviations in TFP are the same as the deviations in $\underline{z}^{\alpha}$, as follows from (15). In panel (e), income deviations characterize simultaneously the deviations in output (y), wage bill ($w\ell$), profits (Π), capital income ($r^*\kappa$), and hence capital (κ), as follows from Lemma 2.

Figure 3(e) shows that during the initial phase of the transition, the optimal policy increases GDP as well as the incomes of all groups of agents—workers, active entrepreneurs, and rentiers (inactive entrepreneurs)—according to Lemma 2. Output y is higher due to both a higher labor supply ℓ and increased capital demand κ, while the capital-output ratio κ/y remains constant according to (18). This increase in demand is met by an inflow of capital, which is in perfectly elastic supply in a small open economy.

The effect of the increase in inputs ℓ and κ is partly offset by a reduction in TFP due to a lower productivity cutoff $\underline{z}$, as less productive entrepreneurs need to become active to absorb the increased labor supply.

Although our numerical example is primarily illustrative, it can be seen that the transition dynamics in this economy, where heterogeneous producers face collateral constraints, may take a very long time, consistent with the observed post-war growth miracles (for further discussion, see Buera and Shin (2013)). Furthermore, the quantitative effects of the Ramsey labor market policies may be quite pronounced. In particular, in our example, the Ramsey policy increases labor supply by up to 18% and GDP by up to 12% during the initial phase of the transition, which lasts around 20 years. This is supported by an initial labor supply subsidy of over 20%, which switches to a 12% labor tax in the long run. Despite the increased labor income, workers initially suffer in flow utility terms (Figure 3(f)) due to increased labor supply. Workers are compensated with a higher utility in the future, reaping the benefits of both higher wages and lower labor supply, and gain on net intertemporally. We revisit these results in Section 3.4, where we consider overlapping generations of finitely-lived households that also face borrowing constraints (in particular, cf. Appendix Figure A8).

Implementation. The Ramsey-optimal allocation can be implemented in a number of different ways. For concreteness, we focus here on the early phase of the transition, when the planner wants to increase labor supply. The way we set up the problem, the optimal allocation during this initial phase is implemented with a labor supply subsidy, $\varsigma_\ell(t) \equiv -\tau_\ell(t) > 0$, financed by a lump-sum tax on workers (or government debt accumulation). In this case, workers' gross labor income including subsidy is $(1 + \varsigma_\ell)(1 - \alpha)y$, while their net income subtracting the lump-sum tax is still given by $(1 - \alpha)y$, hence resulting in no direct change in their budget set. Note that increasing labor supply unambiguously increases net labor income ($w\ell$), but decreases the net wage rate (w) paid by firms. This is why we sometimes refer to this policy as *wage suppression*.

An equivalent implementation is to give a wage bill subsidy to firms financed by a lump-sum tax on workers. In this case, the equilibrium wage rate increases, but the firms pay only a fraction of the wage bill, and the resulting allocation is the same. There are, of course, alternative implementations that rely on directly controlling the *quantity* of labor supplied, rather than its *price*, such as *forced labor*—a forced increase in the hours worked relative to the competitive equilibrium. Such a non-market implementation pushes workers off their labor supply schedule and the wage is determined by moving along the labor demand schedule of firms. Our theory is silent on the relative desirability of one form of intervention over another. See Weitzman (1974) for a discussion. Furthermore, desirable allocations may be achieved without any tax interventions by means of market regulation, for example, by shifting the bargaining power from workers to firms in the labor market, as is often the case in practice (see Supplemental Material Appendix B and Appendix A2.3 for further discussion).

The general feature of all these implementation strategies is that they make workers work hard even though wages paid by firms are low. Put differently, the common feature of all policies is their *pro-business* tilt in the sense that they reduce the effective labor costs to firms, allowing them to expand production and generate higher profits, in order to facilitate the accumulation of wealth in the absence of direct transfers to entrepreneurs.

Learning-by-Doing Analogy. One alternative way of looking at the planner's problem (P1) is to note that, from (16), GDP depends on current labor supply $\ell(t)$ and entrepreneurial wealth $x(t)$. From (19), entrepreneurial wealth accumulates as a function of past profits, which are a constant fraction of past aggregate incomes, or outputs. Therefore, current output depends on the entire history of past labor supplies, $\{\ell\}_{t\geq 0}$, and the

initial level of wealth, x_0. Importantly, in the competitive equilibrium, workers do not take into account the effect of their labor supply decisions on the accumulation of this state variable. In contrast, the planner internalizes it. This setup, hence, is isomorphic at the aggregate to a model of a small open economy with a learning-by-doing externality in production (see, e.g., Krugman (1987), Matsuyama (1992)). Entrepreneurial wealth in our setup plays the same role as physical productivity in theories with learning-by-doing. As a result, some of our policy implications have a lot in common with those that emerge in economies with learning-by-doing externalities, as we discuss in Section 5. That being said, the detailed micro-structure of our environment not only provides discipline for the aggregate planning problem, but also differs in qualitative ways from an environment with learning-by-doing. For example, as explained above (and in more detail in Appendix A2.2), transfers between entrepreneurs and workers would be a powerful tool in our environment, but have no bite in an economy with learning-by-doing.

Pareto Weight on Entrepreneurs. Our analysis generalizes in a natural way to the case where the planner puts an arbitrary nonzero Pareto weight on the welfare of the entrepreneurs. In Appendix A1.3, we derive the expected present value of an entrepreneur with assets a_0 at time $t = 0$, denoted $V_0(a_0)$. In Appendix A4.2, we extend the baseline planner's problem (P1) to allow for an arbitrary Pareto weight, $\theta \geq 0$, on the utilitarian welfare function for all entrepreneurs, $\mathbb{V}_0 = \int V_0(a)\,\mathrm{d}G_{a,0}(a)$. We show that the resulting optimal policy parallels that characterized in our main Proposition 1, with the optimal labor tax now given by

$$\tau_\ell^\theta(t) = \gamma\big(1 - \nu(t)\big) - \theta\gamma\frac{e^{(\rho-\delta)t}}{\delta\bar{\mu}x(t)}. \tag{32}$$

Therefore, the optimal tax schedule simply shifts down (for a given value of ν) in response to a greater weight on the entrepreneurs in the social objective. That is, the transition is associated with a larger subsidy to labor supply initially and a smaller tax on labor later on. In this sense, we view our results above as a conservative benchmark, since even when the planner does not care about entrepreneurs, she still chooses a pro-business policy tilt during the early transition.

3.3. *Additional Tax Instruments*

In order to evaluate the robustness of our conclusions, we now briefly consider the case with additional tax instruments which directly affect the decisions of entrepreneurs. In particular, we introduce a capital subsidy ς_k, which in our environment is equivalent to a credit subsidy.[23] The key result of this section is that, despite the availability of this more direct policy instrument to address financial constraints, it is nevertheless optimal to distort workers' labor supply decisions by suppressing wages early on during the transition and increasing them in the long run. In Appendix A3.3, we characterize a more general case, which additionally allows for a revenue (sales) subsidy, a profit subsidy, and an asset subsidy to entrepreneurs.

Specifically, we now consider the profit maximization of an entrepreneur that faces a wage-bill subsidy ς_w and a cost of capital subsidy ς_k:

$$\pi(a,z) = \max_{\substack{n\geq 0,\\ 0\leq k\leq \lambda a}} \big\{A(zk)^\alpha n^{1-\alpha} - (1-\varsigma_w)wn - (1-\varsigma_k)r^*k\big\}. \tag{33}$$

[23] Indeed, a subsidy to r^*k in our model is equivalent to a subsidy to $r^*(k-a)$, as all active entrepreneurs choose the same leverage, $k = \lambda a$.

Credit (capital) subsidies are, arguably, a natural tax instrument to address the financial friction, and they have been an important element of real-world industrial policies (see Supplemental Material Appendix B as well as McKinnon (1981), Diaz-Alejandro (1985), Leipziger (1997)).

In the presence of the additional subsidies to entrepreneurs, the equilibrium characterization in Lemma 2 no longer applies and needs to be generalized, as we do in Appendix A3.3. In particular, we show that the aggregate output function now generalizes (16) and is given by

$$y(x, \ell) = (1 - \varsigma_k)^{-\gamma(\eta-1)} \Theta x^{\gamma} \ell^{1-\gamma},$$

with γ and Θ defined as before. Furthermore, the planner's problem has a similar structure to (P1), with the added optimization over the choice of the additional subsidies. This allows us to prove the following:

PROPOSITION 2: *When the planner's only policy tools are a wage bill subsidy and a capital subsidy to entrepreneurs, the optimal Ramsey policy is to use both of them in tandem, and set them according to*

$$\frac{\varsigma_w}{1 - \varsigma_w} = \frac{\varsigma_k}{1 - \varsigma_k} = \frac{\alpha}{\eta}(\nu - 1), \tag{34}$$

where ν is the shadow value of entrepreneurial wealth, which evolves as described in Section 3.2.

The key implication of Proposition 2 is that even when a credit (capital) subsidy ς_k is available, the planner still finds it optimal to use the labor (wage bill) subsidy ς_w alongside it. This is because credit subsidies introduce distortions of their own by affecting the extensive margin of selection into entrepreneurship.[24] As a result, the planner prefers to combine both instruments in order to minimize the amount of created deadweight loss. Furthermore, note that the two subsidies are perfectly coordinated, leaving undistorted the capital-labor ratio chosen by the entrepreneurs. Last, observe that the shadow value of entrepreneurial wealth ν is, as before, a sufficient state variable for the stance of the optimal policy, given the parameters of the model.[25] When $\nu > 1$, entrepreneurial wealth is scarce, and the planner subsidizes both entrepreneurial production margins. As wealth accumulates, ν declines and eventually becomes less than 1, a point at which the planner starts taxing both margins, just like in Proposition 1. As a general principle, whenever entrepreneurial wealth is scarce, the planner utilizes all available policy instruments in a pro-business manner.

Lastly, we briefly comment on wealth transfers as a policy tool. In our analysis, we ruled out direct redistribution of wealth, either between entrepreneurs of different productivities, or between entrepreneurs and workers. In Appendix A2.2, we relax the latter restriction and allow for direct transfers between workers and entrepreneurs, which in

[24]Note that the most direct way to address the financial friction is to relax the collateral constraint (5) by increasing λ, which would lead in equilibrium to reallocation of capital from less to more productive entrepreneurs and exit of the marginal ones. In contrast, a capital subsidy leads to additional entry on the margin, resulting in greater production inefficiency and lower TFP.

[25]Compare (34) with (30): in both cases, the optimal subsidies are proportional to $\frac{\alpha}{\eta}(\nu - 1)$, given the definition of γ in (16). Also note that the same allocation as in Proposition 2 can be achieved by replacing the wage subsidy ς_w with a labor income subsidy, setting $\tau_\ell = -\frac{\varsigma_w}{1-\varsigma_w} = \frac{\alpha}{\eta}(1 - \nu)$.

certain cases can also be engineered using a set of available distortionary taxes (see Appendix A3.3). Here again, our conclusion regarding the optimality of a labor subsidy when entrepreneurial wealth is low remains intact, as long as the feasible transfers are finite. Put differently, the only case in which there is no benefit from increasing labor supply in the initial transition phase is when an unbounded transfer from workers to entrepreneurs is available, which allows the planner to immediately jump the economy to its steady state.[26]

3.4. *Finite Lives and Household Borrowing Constraints*

We now extend our analysis to overlapping generations (OLG) of workers, who face a hazard of dying and are replaced by new generations, as in Blanchard (1985) and Yaari (1965). Later, we additionally introduce borrowing constraints on the workers, to capture the idea that financial frictions directly affect all agents in the economy. One may suspect that the planner's priorities and allocations change considerably in these cases, because now the costs and benefits of the policies are distributed unevenly across generations. Yet, we show that our main insights are robust, perhaps surprisingly, to these extensions.

We assume that a worker lives to age $s \geq 0$ with probability e^{-qs}, where q is an instantaneous death rate common across all age groups. The results can be extended to the case of non-constant death hazard over the life cycle as in Calvo and Obstfeld (1988). At each time t, agents are born at the same rate q so that the total population is stable, and normalized to 1. Hence, at any point in time, the number (density) of s-year-olds is qe^{-qs}. Individuals born at date τ (cohort τ) have lifetime utility $U(\tau) = \int_\tau^\infty e^{-(\rho+q)(t-\tau)} u_\tau(t)\,\mathrm{d}t$, where $u_\tau(t) = u(c_\tau(t), \ell_\tau(t))$ is the period utility at time t of a member of cohort τ. We further assume that the wealth of the dying workers is passed on to the surviving generations of workers, via bequest or a perfect annuity market. Then, aggregating over the cross-sectional age distribution, the resulting budget constraint of the household sector is still given by (25). Since nothing changes on the side of entrepreneurs, the planner faces the same implementability conditions (25)–(26), and Lemma 3 still applies.

It remains to specify the planner's objective. In particular, we need to take a stand on how the planner weighs cohorts born at different dates. We assume that the planner discounts the lifetime utilities of different generations at rate ϱ, a rate which need not equal the individual time preference rate ρ. We further follow Calvo and Obstfeld (1988) and assume that social welfare evaluated at date 0 is given by

$$W_0 = \int_{-\infty}^{\infty} e^{-\varrho\tau} q U_0(\tau)\,\mathrm{d}\tau \quad \text{where } U_0(\tau) = \begin{cases} U(\tau), & \tau \geq 0, \\ \displaystyle\int_0^\infty e^{-(\rho+q)(t-\tau)} u_\tau(t)\,\mathrm{d}t, & \tau < 0. \end{cases} \tag{35}$$

In words, $U_0(\tau)$ is the remaining lifetime utility as of date 0 for cohort τ, *discounted to the date of birth*.[27] That is, the planner maximizes W_0, which uses her time preference rate ϱ to aggregate $U_0(\tau)$ for all cohorts $\tau \in (-\infty, \infty)$, and where q is each cohort's size at birth.

[26] With unlimited transfers, the planner can fully relax the aggregate financial constraint of entrepreneurs in (P1), and hence ensure $\nu \equiv 1$ in every period and avoid the need to use distortionary policy instruments.

[27] It may seem somewhat unnatural to discount the utility of those already alive back to their birthdates $\tau \leq 0$. However, Calvo and Obstfeld (1988) showed that this approach (unlike others) results in a time-consistent planner's objective, even when $\varrho \neq \rho$ (see Appendix A3.4).

Next, using a change of variable from cohort τ to age $s = t - \tau$, we rewrite the welfare criterion in (35) as

$$W_0 = \int_0^\infty e^{-\varrho t} V(t)\,\mathrm{d}t, \quad V(t) \equiv \int_0^\infty q e^{-qs} \cdot e^{-(\rho-\varrho)s} \cdot u\big(\tilde{c}(t,s), \tilde{\ell}(t,s)\big)\,\mathrm{d}s, \tag{36}$$

where $\tilde{c}(t,s)$ and $\tilde{\ell}(t,s)$ are the consumption and labor supply of s-year-old workers at time t. Intuitively, $V(t)$ represents the utility flow from all workers alive at time t, aggregating across the cross-sectional age distribution with density qe^{-qs}, with $(\rho - \varrho)$ reflecting the relative weight the planner puts on younger generations at a given point in time. The key insight of Calvo and Obstfeld (1988) is that optimal allocations can be conveniently found by means of a two-step procedure. First, statically maximize $V(t)$ subject to the constraint that the integrals of $\tilde{c}(t,s)$ and $\tilde{\ell}(t,s)$ equal aggregate consumption and labor supply $c(t)$ and $\ell(t)$: formally, $\int_0^\infty qe^{-qs}\tilde{c}(t,s)\,\mathrm{d}s \le c(t)$ and $\int_0^\infty qe^{-qs}\tilde{\ell}(t,s)\,\mathrm{d}s \ge \ell(t)$. Second, choose the time path of $c(t)$ and $\ell(t)$ that maximizes W_0.

We first consider a benchmark case of $\varrho = \rho$, that is, of a planner who places equal weight on all generations. It is then intuitive that the planner gives the same allocation to people of all ages at any given point in time, $\tilde{c}(t,s) \equiv c(t)$ and $\tilde{\ell}(t,s) \equiv \ell(t)$ for all s. Therefore, the planner's objective in (36) simply becomes $W_0 = \int_0^\infty e^{-\rho t} u(c(t), \ell(t))\,\mathrm{d}t$, equivalent to that in (P1). That is, when $\varrho = \rho$, the planner's problem with finitely-lived workers is completely isomorphic to the case with infinitely-lived workers, and as a result, *none* of the optimal policy implications change in any way relative to Proposition 1 and Figures 1–3. While this result may seem surprising at first, it is nonetheless intuitive: when a worker dies, she is replaced by another worker with an identical utility flow from allocations, and since the planner puts equal weight on these two workers, her objective is unaffected by finite lives.[28]

Next, consider the case with $\varrho > \rho$ capturing the planner's solidarity with earlier generations. From (36), one can then see that an unconstrained planner would discriminate between older and younger generations by allocating less consumption to younger workers at a given point in time. Such allocations are arguably unnatural because implementing them requires age-dependent tax instruments, and therefore, we impose an additional constraint on the planner that $\tilde{c}(t,s) \equiv c(t)$ and $\tilde{\ell}(t,s) \equiv \ell(t)$ for all s at any given point in time t. As a result, $V(t) = \frac{q}{\rho+q-\varrho} u(c(t), \ell(t))$, and the planner's objective is $W_0 \propto \int_0^\infty e^{-\varrho t} u(c(t), \ell(t))\,\mathrm{d}t$. Therefore, the analysis is still isomorphic to solving the problem in (P1), but now with a higher discount rate $\varrho > \rho = r^*$. A natural upper limit on the planner's discount rate is $\varrho = \rho + q$, which is equivalent to the planner giving an exclusive weight to the earliest cohort.[29]

In Appendix A3.4, we show that all optimality conditions in this case are unchanged, except for (27) which becomes $\dot{u}_c/u_c = \varrho - r^* > 0$, that is, the planner chooses to front-load consumption. The characterization of the optimal policy (29)–(30), however, is unchanged, and the qualitative pattern of the initially increased labor supply and lowered

[28] Finite lives, however, require a brief discussion of decentralization of the optimal Ramsey plan. In one case, the new generations of workers need to be endowed with the same wealth as all surviving workers, by means of bequests or government transfers. This is, however, not necessary in the presence of perfect borrowing markets, in which case the government needs to subsidize the consumption of earlier cohorts (when productivity and output are low) by accumulating debt and levying taxes in the long run. We discuss below the case with borrowing constraints, where such transfers are not possible.

[29] To see this, assume that the planner only cares about the oldest cohort, which amounts to maximizing $\int_0^\infty e^{-(\rho+q)t} u(c(t), \ell(t))\,\mathrm{d}t$, corresponding to W_0 in the text when $\varrho = \rho + q$.

wages still applies. In fact, if utility features no income effects (i.e., under GHH preferences), the time path of the optimal labor tax $\tau_\ell(t)$ is independent of the value of ϱ. Therefore, the main insights of our analysis are robust, perhaps surprisingly, to overlapping generations of workers even under a present-biased planner. Indeed, when the planner can freely borrow in international capital markets, she favors early generations solely via increased consumption, keeping unchanged the optimal policy on the supply side.

This analysis naturally leads to the question of borrowing constraints on households and the planner. First, we are interested whether finite horizons have greater bite in the presence of borrowing constraints. Second, we generalize our analysis to feature financial (borrowing) constraints on all agents in the economy, not just the entrepreneurs. For simplicity, we consider the case in which households cannot borrow at all and are hand-to-mouth, and we assume the planner needs to honor this constraint. We show in Appendix A3.4 that, while the expression for the optimal tax (30) does not change in this case, the shadow value of entrepreneurial wealth ν (equation (29)) is different. In particular, the optimal time path of the labor tax becomes less steep, featuring smaller subsidies in the short run. This difference from our baseline is more pronounced the more present-biased the planner is, that is, the larger is $\varrho - \rho > 0$. Indeed, without the ability to shift consumption towards earlier generations, the usefulness of the labor wedge is reduced, since it delivers only delayed productivity gains. Nevertheless, it remains true even in this case that low financial wealth of entrepreneurs provides a rationale for a stage-dependent policy intervention that subsidizes labor supply early on, and taxes it later in the transition. We illustrate these results in Appendix Figure A8.

4. QUANTITATIVE EXPLORATION

In the previous sections, we developed a tractable model of transition dynamics with financial constraints, which allows for a sharp analytical characterization of the optimal dynamic policy interventions (see Propositions 1 and 2). Towards this goal, we adopted a number of assumptions which allow for tractable aggregation of the economy and result in a simple characterization of equilibrium dynamics under various government policies (see Lemma 3). This naturally raises the question of robustness of the results to relaxation of the main assumptions, which is one of the goals of this section. Doing so requires giving up analytical tractability and extending the model to a richer quantitative environment. We follow the benchmark quantitative framework in the macro-development literature and calibrate our quantitative model to a typical developing economy. The second goal of this section is to evaluate the *quantitative importance* of alternative policies, not necessarily optimal ones, for welfare and growth in the emerging economies. As we will see, the results in this section confirm our main message that pro-business policies are especially important for growth at earlier stages of development, and that such policies can be welfare-improving even from workers' perspective.

4.1. *Quantitative Model*

The economy is similar to the baseline model in Section 2 with four main differences. First, production functions now feature decreasing returns to scale. This relaxes the feature of the baseline model that all active producers are collateral-constrained, allowing some of them to grow out of the financial frictions over time. Second, we relax the assumption that productivity shocks are i.i.d. over time and consider a persistent productivity process. Third and relatedly, in the baseline model, the cross-sectional productivity

distribution is Pareto with unbounded support. In the model of this section, the productivity process instead evolves on a compact interval and hence the stationary productivity distribution has bounded support. Finally, following the extension in Section 3.4, we assume that not only entrepreneurs but also households are financially constrained.

The entrepreneurs still maximize (3) subject to (6) and collateral constraint (5). However, their production function now features decreasing returns, $\beta < 1$:

$$y = A\left[(zk)^{\alpha} n^{1-\alpha}\right]^{\beta},$$

instead of the constant returns technology in (4). Productivity z follows a jump-diffusion process in logs (described more formally in Appendix A5):

$$\mathrm{d}\log z_t = -\nu \log z_t \,\mathrm{d}t + \sigma \,\mathrm{d}W_t + \mathrm{d}J_t. \tag{37}$$

In the absence of jumps ($\mathrm{d}J_t = 0$), this is an Ornstein–Uhlenbeck process, a continuous-time analogue of an AR(1) process, with mean-reversion ν and innovation dispersion σ. We further assume that the process is reflected both above and below, and therefore lives on a bounded interval $[\underline{z}, \bar{z}]$. Finally, jumps arrive infrequently at a Poisson rate ϕ, and, conditional on a jump, a new productivity z' is drawn from a truncated Pareto distribution with tail parameter $\eta > 1$ and support $[\underline{z}, \bar{z}]$.

In contrast to our baseline model, we now assume that workers cannot borrow, and therefore are hand-to-mouth along the equilibrium growth trajectory. Therefore, they effectively maximize $u(c, \ell)$ period-by-period subject to $c = (1 - \tau_\ell) w\ell + T$, with the lump-sum transfers distributing the collected tax revenue back to the households. As in the quantitative examples in our baseline model, workers have balanced growth preferences with a constant Frisch elasticity, $u(c, \ell) = \log c - \frac{1}{1+\varphi}\ell^{1+\varphi}$. Finally, as in Midrigan and Xu (2014), we assume that an exogenous fraction $(1 - \omega)$ of the population are workers and a fraction ω are entrepreneurs.

These changes to the model, particularly the adoption of decreasing returns, imply that the state space of the model now necessarily includes the time-varying joint distribution of endogenous wealth and exogenous productivity, $\mathcal{G}_t(a, z)$. The enormous (infinite-dimensional) state space of our quantitative model makes it extremely difficult to analyze optimal policy outside of stationary equilibria. Precisely this problem has been the main impediment to this type of analysis in the earlier literature. In particular, it becomes computationally infeasible to study fully general time-varying optimal policy in which the tax instruments are arbitrary functions of time as is the case in our baseline analysis.[30]

To make progress under these circumstances, we adopt a pragmatic approach and restrict the time-dependence of the policy instruments in a parametric way. Motivated by the results of Section 3, as illustrated in Figures 1 and 2, we restrict the time paths of the tax policy to be an exponential function of time:

$$\tau_\ell(t) = e^{-\gamma_\ell t} \cdot \underline{\tau}_\ell + \left(1 - e^{-\gamma_\ell t}\right) \cdot \bar{\tau}_\ell, \tag{38}$$

[30]Some existing analyses of optimal policy do take into account transition dynamics but restrict tax instruments to be constant over time, making the optimal policy choice effectively a static problem (see, e.g., Conesa, Kitao, and Krueger (2009)). Our main result that the sign of the optimal policy differs depending on the stage of development emphasizes the importance of examining time-varying optimal policy. Some recent work has developed numerical methods for finding social optima with fully time-varying tax instruments (Nuño and Moll (2018)), but this is currently only feasible in simpler environments.

parameterized by a triplet of the initial tax rate $\underline{\tau}_\ell$, the steady-state tax rate $\bar{\tau}_\ell$, and the convergence rate γ_ℓ. Under this parameterization, the *half-life* of the policy, or the time it takes to go halfway from $\underline{\tau}_\ell$ to $\bar{\tau}_\ell$, is equal to $\log 2/\gamma_\ell$. This parametric approach reduces the infinite-dimensional optimal policy problem to one of finding three optimal policy parameters $(\underline{\tau}_\ell, \bar{\tau}_\ell, \gamma_\ell)$.

Lastly, we assume that the planner chooses these tax parameters to maximize a weighted average of initial welfare of workers and entrepreneurs:

$$\mathcal{V}_0 = (1-\omega)\int_0^\infty e^{-\rho t} u(c_t, \ell_t)\,\mathrm{d}t + \theta\omega \int v_0(a,z)\,\mathrm{d}\mathcal{G}_0(a,z), \tag{39}$$

where $v_0(a,z)$ is the expected lifetime utility of an entrepreneur starting at time $t=0$ with wealth a and productivity z, ω is the population share of entrepreneurs, and θ is their Pareto weight in the planner's problem. Appendix A5 spells out in more detail the model's equilibrium conditions, including the system of coupled Hamilton–Jacobi–Bellman and Kolmogorov Forward equations that describe the problem of entrepreneurs and the evolution of the distribution $\mathcal{G}_t(a,z)$ (see also Achdou, Han, Lasry, Lions, and Moll (2017)).

4.2. *Parameterization*

We parameterize the model to capture relevant features of a typical emerging economy, with an initial condition aimed to represent an early stage of development. Our model is similar to the benchmark quantitative models in the literature, namely Buera and Shin (2013) and Midrigan and Xu (2014), and therefore we follow a similar calibration strategy.[31] In Appendix Table A2, we describe the calibrated parameter values, and we discuss the important ones here, relegating the details to Appendix A5.

First, we take as the initial wealth distribution $\mathcal{G}_0(a,z)$ a ten-fold scaled-down version of the stationary long-run wealth distribution in the absence of policy. In other words, the initial wealth is one-tenth of the final wealth under laissez-faire, while the correlation between a and z is the same. This ten-fold increase in the wealth of entrepreneurs contributes to more than doubling of the GDP along the transition path with growth rates exceeding 5% over the first 12 years of transition.[32] Second, we set the parameter governing the tightness of financial constraints (5) to $\lambda = 2$. This results in a steady-state external finance to GDP ratio of 2.3, which is in between the values of the 2011 external finance to GDP ratios of China (2.0) and South Korea (2.5) based on data by Beck, Demirguc-Kunt, and Levine (2000).

Third, the literature on the macroeconomic effects of financial frictions in developing countries emphasizes the importance of the stochastic process for productivity z (Midrigan and Xu (2014), Moll (2014)). Asker, Collard-Wexler, and de Loecker (2014; henceforth, ACD) have estimated productivity processes for 33 developing countries and we use their estimates to discipline the process in our model. We set ν so that the annual autocorrelation of productivity equals 0.85, the average of the country-specific estimates

[31] Our model is closest to the baseline one-sector model in the working paper version of Midrigan and Xu (2010), who calibrated it to the South Korean development experience.

[32] For comparison, South Korea's per capita GDP increased by a factor of about 10 between 1970 and 2010. Of course, our model omits many of the real-world contributors to South Korea's growth, chief among them sustained productivity growth. Put differently, our calibration suggests that the TFP gains arising from financial deepening and improved capital allocation can alone account for over 20% of Korea's growth.

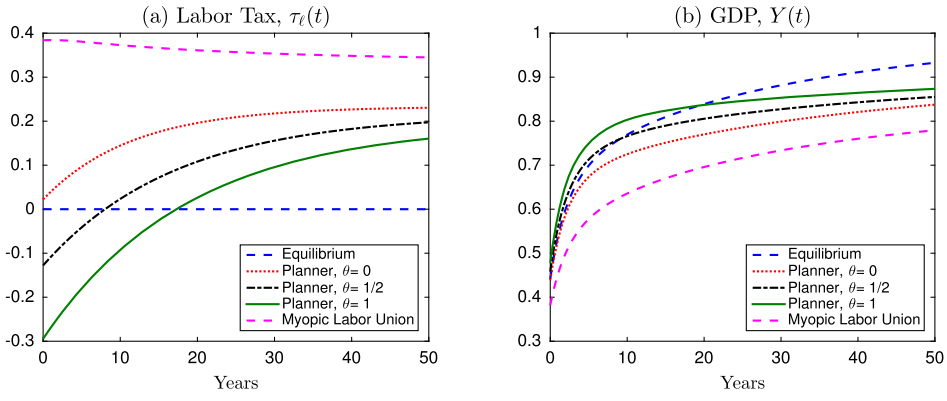

FIGURE 4.—Optimal policy in the quantitative model. Note: Panel (a) plots the optimal labor tax schedules $\tau_\ell(t)$ corresponding to different Pareto weights of entrepreneurs $\theta \in \{0, 1/2, 1\}$, as well as the labor tax imposed by a myopic labor union, as explained in the text. Panel (b) plots the evolution of GDP, $Y(t) = \int y_t(a, z)\, \mathrm{d}\mathcal{G}_t(a, z)$, corresponding to the policies in panel (a), as well as the GDP dynamics under laissez-faire equilibrium, which is normalized to 1 in steady state.

in ACD. We set $\sigma = 0.3$, which is towards the lower end of ACD estimates. Last, we set $\phi = 0.1$ implying that Poisson jumps arrive infrequently, on average every ten years.

Finally, we set the population share of entrepreneurs ω equal to one-third, a high incidence common to developing countries, and considerably higher than in developed countries like the United States, where it is 10–15% (see, e.g., Cagetti and De Nardi (2006)). We experiment with three different values of the Pareto weight on entrepreneurs $\theta \in \{0, 1/2, 1\}$. The case $\theta = 0$ corresponds to our baseline in Section 3, where the planner acts exclusively on behalf of workers. The case $\theta = 1$ corresponds to a utilitarian objective which weights all individuals equally, while in the intermediate case $\theta = 1/2$, the planner weights each entrepreneur half as much as each worker.

4.3. *Growth and Welfare With Government Interventions*

We now study the growth and welfare consequences of various government policies. As in Section 3, we start with optimal labor taxes and then explore optimal credit subsidies to entrepreneurs. In addition, we contrast the results with various suboptimal policies, which may arise in practice due to political economy constraints.

We start by exploring the optimal labor tax schedules, $\tau_\ell(t)$, for different Pareto weights on entrepreneurs, $\theta \in \{0, 1/2, 1\}$, which we plot in the left panel of Figure 4. In all three cases, we recover our main result that optimal policy is *stage-dependent*, and the optimal labor tax in the beginning of the transition is lower than in the long run. In particular, a utilitarian planner who puts equal weight on all agents ($\theta = 1$) would start the transition with a large labor supply subsidy of about 30%, and impose a labor tax in the long run equal to nearly 20%. Furthermore, the optimal policy subsidizes labor over an extended period of time, with the half-life of the policy equal to 13 years, and with 17 years before the subsidy is converted into a tax. This policy has a sizable effect on the GDP growth rates, increasing them from just over 5% on average under laissez-faire to 6% on average over the first 10 years of transition. This cumulates to a nearly 10% higher GDP in the 10th year of the policy relative to laissez-faire, as we illustrate in the right panel of Figure 4, which plots the evolution of output under different policy regimes. Furthermore, we check

that this pro-business policy results in a Pareto improvement and increases the welfare of both workers and entrepreneurs, as we discuss further below.

Next, we consider the case with $\theta < 1$, so that the planner's objective in addition to efficiency also favors redistribution from the entrepreneurs towards the workers. As we can see from the left panel of Figure 4, reducing θ uniformly shifts up the optimal tax schedule, consistent with our results in Section 3.2 (recall equation (32)). With $\theta = 1/2$, the planner still starts with a labor supply subsidy equal to 13%, which after 8 years turns into a labor tax that reaches nearly 21% in the long run. The right panel of Figure 4 shows that this greater preference for redistribution towards the workers reduces the growth rate of the economy relative to that achieved under the utilitarian policy with $\theta = 1$. Nonetheless, over the first 10 years, the economy still grows faster than under laissez-faire, due to the optimal labor subsidy. In the long run, the optimal policy involves a labor tax, which acts to redistribute welfare from entrepreneurs to workers, and results in a lower long-run GDP than under laissez-faire.

When the planner cares exclusively about workers, putting a weight of $\theta = 0$ on all entrepreneurs who together constitute a third of the population, the redistributive motive dominates the efficiency motive even early on in the transition. In this case, the planner starts with a positive, albeit tiny, labor tax, which increases over time to above 23%. This leads to uniformly lower growth rates than under laissez-faire, yet workers gain at the expense of entrepreneurs. This, however, is not a general result when $\theta = 0$, and it depends on the initial condition for the wealth distribution of entrepreneurs. For example, if the economy starts out with even more undercapitalized entrepreneurs, with wealth levels scaled down 20-fold rather than 10-fold relative to the long run, the planner chooses to subsidize labor supply to entrepreneurs even when $\theta = 0$, echoing our theoretical results in Proposition 1.

To summarize, our quantitative analysis confirms that pro-business labor market policies in the early transition are optimal, even when the planner puts little weight on the wellbeing of entrepreneurs. To emphasize the importance of stage-dependent pro-business policies, we contrast the results with a particular form of *pro-labor policies*, namely a labor tax chosen by a *myopic labor union*. In particular, at each point in time t, the labor union maximizes the period utility of the workers, $u(c(t), \ell(t))$, without taking into account the equilibrium effects that this policy has on wealth accumulation and endogenous productivity dynamics.[33] We derive the optimal union tax schedule in Appendix A5, and plot it in Figure 4 along with the resulting GDP dynamics under this tax. One important feature is that the union tax starts out high at 38% and decreases over time to 33% in the long run, in contrast with the optimal labor tax which starts low and increases over time. The reason is that the union tax does not factor in the dynamic efficiency consideration and simply depends on the elasticity of aggregate labor demand. The more constrained entrepreneurs are, the lower is the elasticity of labor demand, as they cannot adjust capital when financial constraints bind.[34] Thus, the same financial frictions

[33] Such union policy can also proxy for other sources of labor market imperfections, which reduce equilibrium employment and increase labor costs to the firms, such as firing restrictions and severance payments, common in developing countries with continental-European labor market institutions (see, e.g., Botero, Djankov, La Porta, Lopez-de Silanes, and Shleifer (2004), Helpman and Itskhoki (2010)).

[34] In the analytical model in Section 3, the optimal union tax is always equal to γ, as all active entrepreneurs operate at the borrowing constraint without ever growing out of it. Since the quantitative model features decreasing returns to scale, this is no longer the case, and the fraction of the constrained entrepreneurs decreases as the economy develops. In particular, under laissez-faire, this fraction falls from 44% initially to 28% in the long run.

TABLE I

WELFARE AND GROWTH EFFECTS OF POLICIES[a]

	Welfare Gains (%)		Annualized GDP Growth (%)		
	Overall	Workers	5 Years	10 Years	20 Years
Optimal labor tax	0.503	0.751	9.59	5.51	3.01
Optimal flat labor tax, $\hat{\tau}_\ell = 0.100$	0.241	0.679	8.36	5.13	2.99
Flat labor subsidy, $-\underline{\tau}_\ell = 0.128$	−0.896	−1.442	10.16	6.05	3.46
Myopic union tax	−1.984	−0.378	5.38	3.65	2.28
Optimal credit subsidy	1.533	1.480	9.79	5.68	3.04

[a]Welfare gains in consumption-equivalent terms (i.e., % increase in consumption in every period).

that make pro-business policies optimal result in high labor taxes under a myopic labor union. As a consequence, this static union policy is detrimental to both GDP growth and welfare (see Table I discussed below). Even though this policy by design maximizes workers' current utility, it ends up being detrimental to workers, emphasizing the possible benevolent effects of the pro-business policies early on in the transition and the potential costs of the pro-labor policies in the financially-constrained economies.

We summarize the growth and welfare effects of various policies in Table I. We use a standard consumption-equivalent welfare metric, that is, the percentage change in consumption one would have to give individuals in the laissez-faire equilibrium each year to make them as well off as under the alternative policies (see Appendix A5 for details). For brevity, we focus on the intermediate case with the welfare weight on entrepreneurs $\theta = 1/2$. The table reveals that the optimal labor tax in this case, which is pro-business in the short run and pro-worker in the long run, increases the combined welfare of workers and entrepreneurs by 0.5% in consumption-equivalent units. That is, the welfare increase from this policy is equivalent to the effect of a 0.5% increase in consumption in every period for every agent in the economy. Importantly, the optimal policy increases worker welfare by even more, namely by 0.75% in consumption equivalent. These numbers can be contrasted with those in the literature estimating the welfare cost of business cycles which are typically on the order of 0.01% (see, e.g., Lucas (2003)). That is, the welfare gains from the optimal development policies are at least one order of magnitude larger than those from eliminating the business cycle. The table also shows that, for developing countries, the potential welfare and growth losses from myopic labor union policy are even larger.

To understand how important it is for policies to be stage-dependent, we also consider the welfare effects of various policies with time-invariant (flat) taxes. First, we consider an optimal flat tax. That is, we solve the same problem as above but under the restriction that $\tau_\ell(t) = \hat{\tau}_\ell$ is constant for all t. The optimal flat tax is $\hat{\tau}_\ell = 10\%$ and the resulting welfare gain is only 0.24%, that is, less than half of the welfare gain under the optimal policy.[35] While this policy has only modest losses for workers relative to the best labor tax policy, the costs of this policy for GDP growth are considerably larger, resulting in 4% lower GDP after 10 years. Second, we consider the case in which the tax (subsidy) rate is set at $\underline{\tau}_\ell = -13\%$ and is then never adjusted, reflecting the possible power capture by organized lobbying groups. Such policy capture has large welfare costs for workers after short-run

[35]Note that the optimal flat tax is different from the optimal steady-state tax, which does not take into account the welfare effects of transition, by analogy with the *golden rule* savings rate in capital accumulation.

positive growth effects (cf. Buera, Moll, and Shin (2013)). These two results emphasize that the ability to subsidize labor supply to entrepreneurs early on in the transition is essential to ensure maximum welfare gains for both society at large and workers separately, but only provided that this policy is reversed when the economy becomes sufficiently developed.

Lastly, we study the optimal credit subsidy, which we parameterize analogously to the labor tax in (38). In the case $\theta = 1/2$, the optimal credit subsidy drops from an initial value of 100% to a long-run value of -70% with a half life of 7 years. The last row of Table I reports the resulting welfare effects, which are large and positive for both workers and entrepreneurs. The optimal credit subsidy mildly speeds up economic growth, yet doubles the welfare gains for workers and triples the welfare gains for the economy as a whole when compared with the optimal labor tax.[36] This echoes our Proposition 2, which emphasizes that in a constrained economy, the planner would choose to use all available policy instruments to help the economy build entrepreneurial net worth in the short run and later use taxes to redistribute from entrepreneurs to workers to maximize their welfare gains.

Taken together, the results in this section again confirm our main message that probusiness policies are especially important for growth at earlier stages of development, and that such policies can be welfare-improving even from workers' perspective.

5. OPTIMAL POLICY IN A MULTI-SECTOR ECONOMY

We now extend our analysis to a multi-sector environment. This allows us to study the optimal industrial policies and address a number of popular policy issues, such as promotion of comparative advantage sectors, optimal exchange rate policy, and infant industry protection. We summarize our main results here and provide the details of the environment and derivations in Appendix A6.

We assume households have general preferences $u = u(c_0, c_1, \ldots, c_n)$ over $n+1$ goods (sectors). Good $i = 0$ is an internationally-traded numeraire good with price normalized to $p_0 = 1$. Any of the remaining $i \in \{1, \ldots, n\}$ goods can be either traded (T) or nontraded (N) internationally, and we denote their equilibrium (producer) prices with p_i. Traded good prices are taken as given in the international market ($p_i = p_i^*$ for $i \in T$), while non-traded good prices are determined to clear the domestic market ($c_i = y_i$ for $i \in N$). We further assume, for simplicity, that households supply L units of labor inelastically, and we study the allocation of aggregate labor supply across sectors, $\sum_{i=0}^{n} \ell_i = L$.

The main assumption that we make is that in each sector i, production expertise is entirely in the hands of specialized entrepreneurs, who hold aggregate sectoral wealth x_i and who are subject to financial frictions as described in Section 2. Lemma 2 generalizes in this case to the multi-sector environment, with (nominal) sectoral output given by

$$p_i y_i = p_i^{\zeta} \Theta_i x_i^{\gamma} \ell_i^{1-\gamma}, \quad \text{where } \zeta \equiv 1 + \gamma(\eta - 1),$$

and sectoral wage rates given by

$$w_i = (1-\alpha)\frac{p_i y_i}{\ell_i}, \quad i \in \{0, 1, \ldots, n\}.$$

[36] This is, in part, the case because of the extreme optimal values of the credit subsidy in the short run and the credit tax in the long run, which act as an effective way to redistribution between workers and entrepreneurs. If, however, the maximum sizes of the tax and the subsidy are capped, say at 50%, the quantitative welfare effects of such policy are much more in line with those of the optimal labor tax.

Sectoral productivity Θ_i is defined as before, and may vary due to physical productivity A_i or financial constraints λ_i, which, for example, depend on the pledgeability of sectoral assets (see, e.g., Rajan and Zingales (1998), Manova (2013)).

We first study a planner that has access to sectoral labor income and consumption taxes, $\{\tau_i^\ell, \tau_i^c\}_{i=0}^n$, such that the after-tax (consumer) prices are $\tilde{p}_i = (1+\tau_i^c)p_i$ and the after-tax wage rate is $w = (1-\tau_i^\ell)w_i$, equalized across sectors so that workers are indifferent about which sector to work in. We can also define an *overall sectoral wedge*, $1-\tau_i \equiv \left(1-\tau_i^\ell\right)/\left(1+\tau_i^c\right)$, which summarizes the distortions that arise from both labor and consumption taxes.

Using the expressions above, we can solve for the sectoral labor allocation

$$\ell_i = \frac{\left(\left(1-\tau_i^\ell\right)p_i^\zeta \Theta_i x_i^\gamma\right)^{1/\gamma}}{\sum_{j=0}^{n}\left(\left(1-\tau_j^\ell\right)p_j^\zeta \Theta_j x_j^\gamma\right)^{1/\gamma}} L, \tag{40}$$

which we now study under various policy regimes. Note that labor taxes affect the sectoral labor allocation directly, while consumption taxes affect it indirectly, by changing the equilibrium producer prices p_i.

Laissez-Faire. In laissez-faire equilibrium, with no taxes $\tau_i^\ell = \tau_i^c \equiv 0$, the equilibrium sectoral labor shares are proportional to the labor productivity shifters $p_i^\zeta \Theta_i x_i^\gamma$, which depend in part on the accumulated financial wealth of the sectoral entrepreneurs. In the long run, financial wealth is endogenously accumulated and reflects the fundamental sectoral productivity $p_i^\zeta \Theta_i$. Therefore, the long-run laissez-faire labor allocation does not depend on the initial wealth distribution across sectors $\{x_i(0)\}$, which, however, is important in shaping the allocations along the transition path.

Optimal Policy Interventions. Our theoretical results in Appendix A6 emphasize two main principles of the optimal sectoral policies:

1. zero consumption taxes in the tradable sectors, and labor subsidies to relax the sectoral financial constraints (as in a one-sector economy, cf. (30)):

$$\tau_i^c = 0 \quad \text{and} \quad \tau_i^\ell = \gamma(1-\nu_i) \quad \text{for } i \in T, \tag{41}$$

2. zero overall sectoral wedges (as defined above) in the non-tradable sectors:

$$\tau_i = 0 \quad \text{with } \tau_i^c = -\tau_i^\ell = \frac{1}{\eta-1}(\nu_i - 1) \text{ for } i \in N, \tag{42}$$

where in both cases ν_i is the shadow value of entrepreneurial wealth in sector i.

In a small open economy, the planner chooses not to manipulate consumption prices of tradable goods, as this cannot increase the profitability of the domestic producers due to perfectly elastic foreign supply. The planner instead subsidizes labor reallocation towards the tradable sectors with high shadow value of financial wealth ν_i, that is, the sectors that are undercapitalized relative to their fundamental productivity. In contrast, for non-tradable goods, the planner chooses to manipulate equilibrium prices p_i using consumption taxes, offsetting the resulting sectoral wedges with labor subsidies. This is indeed the least distortive way to increase the profitability of the non-tradable sectors with high shadow values of entrepreneurial wealth.

We consider next three special cases, which illustrate these general principles:

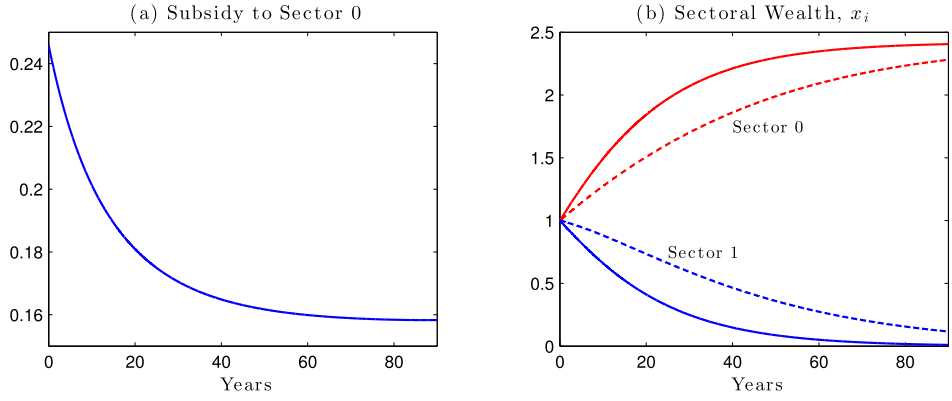

FIGURE 5.—Planner's allocation in an economy with two tradable sectors. Note: The sectors are symmetric in all but their latent comparative advantage, with $p_0^{*\zeta}\Theta_0 > p_1^{*\zeta}\Theta_1$. Panel (a) plots the labor supply subsidy to the comparative advantage sector 0. Panel (b) plots the evolution of the sectoral entrepreneurial wealth under laissez-faire (dashed lines) and optimal sectoral labor taxes (solid lines).

Comparative Advantage and Industrial Policies. The most immediate application of our results is to an economy with tradable sectors only. In this case, the planner simply tilts the allocation of labor across sectors according to the shadow values of entrepreneurial wealth ν_i by means of sectoral labor taxes (see (40) and (41)). This relaxes, over time, the financial constraints that bind the most in the economy.[37] We further show that, for a given level of entrepreneurial wealth x_i, its shadow value ν_i increases with the *latent*, or long-run, *comparative advantage* of the sector, as captured by the revenue productivity $p_i^{*\zeta}\Theta_i$. A sector's *actual*, or short-run, comparative advantage $p_i^{*\zeta}\Theta_i x_i^{\gamma}$ differs from its latent comparative advantage, and depends on accumulated sectoral wealth. In the short run, the country may specialize against its latent comparative advantage, if entrepreneurs in those sectors are poorly capitalized (see Wynne (2005)). Therefore, the planner tilts sectoral labor allocation towards the long-run latent comparative advantage sectors, and hence speeds up the transition in this open economy, as illustrated in Figure 5. This implication of our analysis is consistent with some popular policy prescriptions; however, identifying the latent comparative advantage sectors may be a challenging task in practice (see, e.g., Stiglitz and Yusuf (2001), as well as two empirical approaches to this challenge in Hidalgo, Klinger, Barabási, and Hausmann (2007) and in Lin (2012)).

Real Exchange Rate and Competitiveness. Consider next a two-sector model with a tradable sector $i = 0$ and a non-tradable sector $i = 1$, which allows us to study the real exchange rate implications of the optimal policy. In this economy, the consumption-based real exchange rate is defined by the effective consumer price of non-tradables, $(1 + \tau_1^c)\, p_1$.[38] Specializing the general optimal policy characterization in (41)–(42) to this case, we see that the planner subsidizes the labor supply to the tradable sector $i = 0$ when-

[37]This policy can only be second-best, as it distorts the equalization of marginal products of labor across sectors. In Appendix A6, we generalize this analysis, along the lines of Proposition 2, to allow for additional sectoral policy instruments, including production, credit, and export subsidies.

[38]The CPI-based real exchange rate is given by P/P^*, where P and P^* are the price indexes of the home country and the rest of the world which are functions of the consumer prices of tradable and non-tradable goods. Since we analyze a small open economy, P^* is fixed from the point of view of the home country, and we normalize $p_0 = 1$ and $\tau_0^c = 0$. Therefore, the real exchange rate appreciates whenever the consumer price of non-tradables $(1 + \tau_1^c)\, p_1$ increases.

ever $\nu_0 > 1$, independently of the tightness of the financial constraints in the non-tradable sector. Hence labor is diverted away from non-tradables to tradables and, since production features decreasing returns to labor, equilibrium labor costs in the tradable sector $w_0 = (1 - \alpha_0)y_0/\ell_0$ are compressed, increasing the international competitiveness of the economy. In contrast, this increases relative labor costs in the non-tradable sector, and hence leads to an *appreciated* consumer-price real exchange rate due to more expensive non-tradable goods.[39]

The situation is different when the planner does not have access to any sectoral taxes and has to resort to intertemporal distortions by means of a savings subsidy, or a policy of capital controls and reserve accumulation more commonly used in practice (see Jeanne (2013) for the equivalence result of these policies). By taxing consumption today in favor of future periods, the planner shifts resources away from the non-tradable sector and towards the tradable sector, which is desirable when ν_0 is sufficiently large. As a result, wages and prices of non-tradables as well as consumption of both goods decrease, while the tradable sector expands production and exports facing unchanged international prices.[40] In this case, greater competitiveness of the country in the tradable sector is indeed associated with cheaper non-tradables and a depreciated real exchange rate. This policy, however, induces an unnecessary intertemporal distortion, and hence is at most third-best and is strictly dominated whenever static sectoral taxes are available. To summarize, while the goal of the planner may be to compress wages and shift labor towards the tradable sector, the implications for the real exchange rate are sensitive to the set of the available policy instruments, making it an inconvenient target for policymakers (cf. Rodrik (2008)).

Cohorts of Entrepreneurs and Infant Industry Protection. Last, we consider a generalization of the baseline model with overlapping generations of cohorts of entrepreneurs. We show in Appendix A6 that the optimal multi-sector policy rule (41) still applies in this case. Specifically, instead of sectors, i now refers to the date of birth of the cohort of entrepreneurs, and $p_i \equiv 1$ for all i since we assume that all entrepreneurs produce the same international numeraire good. What makes this setup interesting is if the new cohorts of entrepreneurs have higher levels of productivity, for example, come in with new ideas, captured with an increasing profile of Θ_i with i. At the same time, the young entrepreneurs enter undercapitalized relative to the average existing entrepreneurs in the economy, who have been accumulating financial wealth from their past profits. By analogy with the multi-sector economy, the planner chooses to subsidize the employment of the younger cohorts of entrepreneurs, which is reminiscent of infant industry protection policies, albeit for different reasons than typically put forward (cf. Corden (1997), Chapter 8).

6. CONCLUSION

The presence of financial frictions opens the door for welfare-improving government interventions in product and factor markets. We develop a framework to study the

[39]Furthermore, if $\nu_1 > 1$, the planner subsidizes the non-tradable producers by increasing the equilibrium price of non-tradables using a consumption tax, further appreciating the real exchange rate. In Appendix A6, we generalize this result to the case when the planner cannot directly tax sectoral labor, as distinguishing between tradable and non-tradable labor may be difficult, and can only tax sectoral consumption.

[40]Interestingly, this narrative is consistent with the analysis in Song, Storesletten, and Zilibotti (2014) who argued that, in China, a combination of capital controls and other policies compressed wages and increased the wealth of entrepreneurs, thereby relaxing their borrowing constraints.

Ramsey-optimal interventions which improve welfare and accelerate economic development in financially underdeveloped economies. The main insight of our analysis is that dynamic stage-dependent pro-business policies can generically improve welfare, including that of workers. For example, financial frictions justify a policy intervention that increases labor supply and reduces wages in the early stages of transition so as to speed up entrepreneurial wealth accumulation and relax future financial constraints, which in turn leads to higher labor productivity and wages. However, the optimal policy reverses sign along the transition and becomes pro-worker in the long run. More generally, the optimal policy mix also includes credit and production subsidies, all combined together in a pro-business fashion in the early transition, and then reversed in favor of more redistributive goals later on.

To facilitate the analysis, we develop a particularly tractable version of the workhorse macro-development growth model with heterogeneous entrepreneurs facing financial constraints. This tractability allows for a sharp analytical characterization of the optimal policies along the transition path of the economy. It also allows us to consider a number of extensions, for example to an environment with overlapping generations of finitely-lived workers and entrepreneurs facing similar borrowing constraints. In addition, we can study optimal policies in an environment with multiple tradable and non-tradable sectors, addressing the desirability of various popular industrial and exchange rate policies. Our baseline model relies on a number of strong assumptions, which we relax in our quantitative analysis, thereby confirming the robustness of our findings and the quantitative relevance of the policies we focus on for growth and welfare. Our normative analysis provides an efficiency rationale, but also identifies caveats, for many of the development policies actively pursued by dynamic emerging economies.

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