Dynamic Effects of Static Distortions in Open Economies

Bruno Delalibera[*] Luciene Pereira[†] Heron Rios[‡]

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Abstract

This paper investigates how static distortions present in the sectoral goods market affect growth incentives in open economies. In the model, capital accumulation and exogenous technology adoption jointly generate output growth. Static distortions distance the economy from the actual productivity profile across sectors changing the country specific real rate of return on capital accumulation in the world balanced growth path. We calibrate the model for the Mexican economy between 1995-2011, a period of stagnation of per capita income. Using the World Input-Output Database we retrieve distortions directly from data through statistics implied by the model. Counterfactual exercises show that aggregate losses could be as high as 54%.

Keywords: Misallocation, Open Economy Growth Models, Capital Accumulation, Technology Adoption, Mexico
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[*]Department of Economic Theory, Universitat de Barcelona, Spain, e-mail: brunodelalibera@gmail.com.

[†]Sao Paulo School of Economics, Getulio Vargas Foundation, FGV EESP, Brazil, e-mail: luciene.pereira@fgv.com.

[‡]Center for Applied Microeconomics (C-Micro), Sao Paulo School of Economics, Getulio Vargas Foundation, FGV EESP, Brazil, e-mail: heronrios@hotmail.com.

1 Introduction

During the 1990's a thorough set of macroeconomic policy recommendations known as "Washington Consensus" became widespread. Among other things those recommendations prescribed market oriented policies such as fiscal discipline, trade liberalization and privatization, with the primarily goal of spurring reforms that promote growth (Rodrik, 2006; Estevadeordal and Taylor, 2013). Without ascribing any causality, in fact, the following decades experienced an improvement in many dimensions, for instance, the frequencies of extreme levels of inflation, black market premiums and extremely low trade shares (Easterly, 2019). As macroeconomic stability became a common reality across economies the natural focus redirected from macro towards microeconomic issues. The emergence of an extensive literature on the aggregate effects of resource misallocation driven by static distortions is quite natural in this context. At the same time, a set of policy recommendations (in parallel to the Washington Consensus) aiming to tackle these very same static distortions and trigger economic growth – not achieved by the first macro wave – has been put in place Algazi (2020). However, most of the resource misallocation literature has focused on the static effects of distortions on aggregate productivity (with a few exceptions discussed later). The goal of this paper is to build a bridge between the static distortions and the growth mechanisms that could shed some light into the growth effects of micro reforms.

In order to do that, we build a model where monopolistic competitive firms face a wedge over the price of its differentiated sectoral products along the lines of Hsieh and Klenow (2009). The growth mechanisms considered here are capital accumulation, resulting from saving decisions of the consumers and the sectoral firms demand for capital input, and an exogenous technology adoption that results from international trade in intermediate varieties inputs. The static distortions affect not only sectoral output prices but also the demand for capital and intermediate inputs. In the balanced growth path (BGP), the world economy grows at the exogenous technology adoption rate given by the growth rate of the mass of varieties produced in each country. Changes in the profile of sectoral distortions have two main effects in the model. First, it directly determines the aggregate total factor productivity (TFP) and, thus, the short run change in total output - the static effect. Second, it affects the actual rate of return on capital (that is equalized across countries in the world BGP) which triggers capital accumulation at a rate that differs from the long run rate of technology adoption - the dynamic effect. The combination of the static and dynamic effects determines the economy transition towards a new possibly higher/lower BGP. Therefore, the static distortions change the balance between the growth mechanisms through its effect on the actual rate of return, the ratio between the real rate of return on capital and the final output price.

The model is calibrated to the Mexican economy in the 1995-2011 period. The choice of Mexico is due to the puzzling performance of the economy that experienced catch-up growth during almost thirty years but since the debt crises during the 1980's it faces a sluggish growth (Kehoe and Meza, 2011). What makes it the more surprising is the fact that the economy have being seen as an example of the implementation of the macro reforms without much success in terms of growth response. As a result much of the attention turned to the potential growth benefits of reforms that lower static distortions (Algazi, 2020).

Using data from the World Input-Output Database on imports by sector it is possible to recover the sectoral distortions given the structure of the model. In particular, the ratio of the distortions between any two sectors is determined by the ratio of their respective import participation in sectoral total revenue. The model then is calibrated for the initial and final sample year as the initial and final BGP, respectively. Given the initial and final distortions, the sectoral productivities are calibrated in order to match salient features of the Mexican economy. From the calibrated model, three sets of exercises are conducted. First, the transition is simulated starting from the initial BGP and then a one time permanent shock in both the sectoral productivities and distortions (to their final BGP level) hit the economy. Second, three main counterfactuals are calculated for the long run BGP aggregate output in which the initial distortions remain constant, the sectoral productivities remain constant and lastly, the recovered distortions in 2000 are used - the year in which the import participation reaches its maximum dispersion. The latter counterfactual aims at investigating the worst case scenario for the Mexican economy if the sectoral distortions remained at its highest dispersion level. As it will become clear in the model section, the dispersion of the sectoral distortions play an important role in affecting aggregate TFP. Finally, we investigate the disaggregated effects of a sector by sector ten percent decrease in the distortions.

The first set of results shows that the change in the sectoral distortions induced differential responses of the static versus dynamic effects. While it decreased the aggregate TFP as much as 33%, it increased the actual rate of return spurring capital accumulation that exceeded the rate of technology adoption slightly offsetting the productivity loss. In addition, while most of the sectors experienced a decrease in the distortions (that partially compensated the widespread drop in the sectoral productivities) it remained positively correlated, with high productivity sectors facing higher distortions. The counterfactual results show that keeping the sectoral distortions constant at it is initial level would mildly increase aggregate output relative to the actual final BGP (although both are lower than the initial BGP). However, the composition of the drop is completely different. In the counterfactual only one fourth of the decrease is due to productivity loss as opposed to almost all aggregate output loss in the final BGP. The remaining is accounted for the lower capital accumulation incentives, that is, the dynamic effect. On the other hand, if the productivities remain constant at the initial level the aggregate output would, in fact, be higher than its initial level and most of the effect is accounted for the higher incentives for capital accumulation in excess of technology adoption.

Next, the "stress test" of the Mexican economy, using the model implied distortions in 2000, shows a decrease in the counterfactual aggregate output as high as 56% in one of the exercises, with most of the drop accounted for a decrease in the aggregate TFP. Finally, there is a considerable heterogeneity across sectors in the long run impact of a permanent reduction in the distortions. For instance, a ten percent permanent decrease in distortions in the Education sector would increase long run aggregate output by a factor of 3.2 whereas the same fall in distortions in the Food, Beverages and Tobacco would decrease aggregate output by 5%. These results highlight the importance of accounting for both the static and dynamic effects of changes in the profile of distortions and imply caution in the implementation of policies that try to prompt growth that could, instead, be damaging the aggregate productivity that aimed to increase.

The paper is related to several branches of the literature. The direct link is the literature that investigate the aggregate effects of resource misallocation across heterogeneous producers generated by distortions that prevent the marginal products of inputs to be equalized (Restuccia and Rogerson, 2008; Hsieh and Klenow, 2009, 2014). Among other sources, the tax system in a country, size dependent policies, institutions and regulations are the main examples of such distortions. A complete review of potential sources of distortions and their quantitative importance can be found in Restuccia and Rogerson (2017) and Hopenhayn (2014). In line with this literature, the model presented here assume theoretical exogenous wedges as primitives and assess the impact of such a wedges on aggregate outcomes. This branch of the literature have been named as the indirect approach. This article departures from this literature by focusing on both the static and dynamic effects of sectoral distortions, reflected on the short run aggregate productivity effect and the long run BGP equilibrium effect.

Closer in spirit are two main papers, Bento and Restuccia (2017) and Jovanovic (2014), that are worth mention. Bento and Restuccia (2017) extends the basic factor misallocation model to allow for entry investment and life-cycle productivity investment, implying an endogenous distribution of productivities. They show that the effect of correlated distortions on aggregate TFP is strongly driven by a reduction of the establishment-level entry investment while the decrease in life-cycle productivity offsets the factor misallocation through the increased entry that squeezes the productivity distribution. Although Bento and Restuccia's paper focus on the dynamic effects of the distortions, it does not address the transition as this paper. Moreover, the growth mechanisms are quite different. In this paper, the model focuses on the more neoclassical capital accumulation and exogenous technology adoption instead of productivity investments.

In turn, Jovanovic (2014) features both the transition and the steady state effects of misallocation. He focus on the dynamics of the labor market matching between generations to produce output in a complementary production function. In a overlapping generation model the quality of assignment between members of the two generations (old and young) determine the evolution of human capital formation and the total output. He interprets misallocation as a departure from the ideal matching that results from the increase in the signal-to-noise ratio. Better signals induce better assignment, more human capital formation, higher growth. They also look at the transition when adding more structure (Cobb-Douglas productiona function, log normal distribution of skills) showing that an improvement in the quality of signals induce better assignments, an increase in growth and inequality towards the new BGP values. In contrast, this paper take a broader view of the potential sources of misallocation across different sectors and focus on different growth mechanisms.

There is also a set of papers that belong to the direct approach that focus on specific sources of resource misallocation (Buera and Shin, 2017; Midrigan and Xu, 2014; Moll, 2014). They basically address the common issue of financial frictions that is not the specific goal of this paper. Lastly, Jones (2011) show how the input-output structure of the economy can amplify the effects of shocks in the TFP that reflect the empirically observed differences in output per worker across countries. Jones includes distortions to measure its impact on TFP. In contrast, although this paper features sectoral intermediates tradeable varieties the multiplier here is only the standard capital multiplier as in the neoclassical model. Our focus is to measure both the static and dynamic effects of reforms that change the distortions, not only the steady state TFP effects.

Finally, this paper is related to the literature on the growth effects of trade (Ventura, 1997; Acemoglu and Ventura, 2002). The model here is based on the latter but yet have different goals. Acemoglu and Ventura (2002) show how trade can generate a steady state world equilibrium to an otherwise diverging set of AK economies. In addition, this paper is also related to the literature on the lack of growth in the Mexican economy

(Kehoe and Meza, 2011; Kehoe and Ruhl, 2010; Hanson, 2010; Arias et al., 2010). Most of the literature focus on a more descriptive approach of the economy. We postpone further discussion of this literature to Section 2 where we present the motivation.

The paper proceeds as follows. Section 2 provides a background for the Mexican development experience and the cross country evidence of the relationship between distortions and the rate of return on capital as implied by the model. Section 3 presents the open economy growth model with sectoral distortions. Section 4 presents the data and the calibrations strategy. Section 5 present the main results and counterfactuals. Finally, Section 6 concludes.

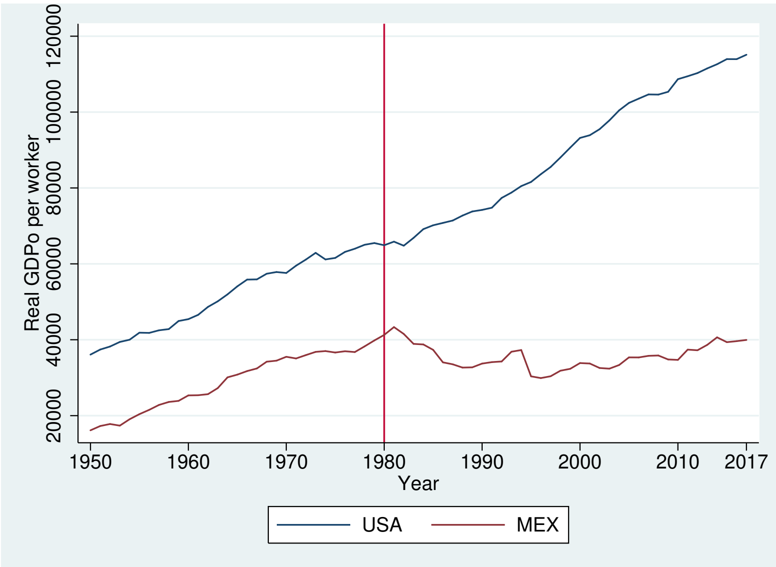
2 The Mexican Stagnation and Misallocation

This section explores the behaviour of the Mexican economy since the 1950's that motivates this paper. In particular, the well-known impressive convergence growth and the following stagnation faced by the economy in the recent decades. The main potential reason for the stagnation is the misallocation caused by a set of policies and malfunctioning institutions. Therefore, we next build a bridge between these static distortions, most likely present in the economies throughout the world, and the growth mechanisms analysing how distortions relate to the real rate of return on capital.

Figure 1 shows the real GDP per worker in Mexico and the U.S. measured in Purchasing Power Parity. The resulting picture of the Mexican economy is striking. For over thirty years Mexico managed to grow faster than the U.S. economy. Between 1950 and 1980 the GDP per worker in Mexico grew by 3.23% per year on average whereas the average growth in the U.S figured around 2.0% per year. According to Kehoe and Meza (2011), this convergence growth is a result of migration from rural areas to urban cities, along with the growth of manufacturing sector and education during the period. However, since the sovereign debt crisis in the early 1980's growth have been lame. From 1980 to 1995 the growth rate of GDP per worker actually shrank at an average rate of 1.83% per year, whereas the U.S. growth kept its pace. Although growth resumed from 1995 to 2017, it continued well below the U.S. at an average rate around 1.3% per year.

This clear change in the trend of the Mexican GDP per worker since the 1980's spurred a lot of attention of academia and policy makers. What makes this trend break all the more puzzling is the fact that since the early 1980's crisis Mexico underwent a path of reforms following a set of prescriptions tailored by international organizations as the IMF, World Bank and think thanks based in Washington that later became known as the "Washington Consensus" (Estevadeordal and Taylor, 2013). Among other things,

Figure 1: Output-side Real GDP per worker in Mexico



the policy prescriptions included opening the economy to international trade and foreign direct investment (FDI), control of public spending, sound monetary policy that restrict inflation and privatization.

The implementation of those guidelines is well documented in the literature. Kehoe and Meza (2011) conduct a thorough investigation of the Mexican economy since 1877. During the 1981-1995 period, as they argue, the government reduced expenditures, increased taxes and the administered prices, and manage to abate inflation to one digit. Also, the government granted constitutional independence to the central bank. As a result, inflation measured by the GDP deflator went from 61% between 1981-82 through 141% in 1986-87 to 8.3% in 1994. Additionally, the number of state owned enterprises in Mexico dropped massively from 1155 in 1982 to 252 in 1994.

In terms of foreign policy Mexico joined the General Agreement on Trade and Tariffs in 1986 and reinforced its commitment with an open and competitive market by signing the North America Free Trade Agreement (NAFTA) in 1994 (Hanson, 2010). In fact, the participation of trade in goods and services in total GDP for the Mexican economy grew from around 27% in 1985 to almost 60% in 1995, with a roughly 20 percentage point increase happening in 1994-95 period, after joining NAFTA (Kehoe and Ruhl, 2010). As a consequence of all the reforming efforts put in place through almost 15 years, Mexico joined the Organization for Economic Cooperation and Development (OECD) in 1994 - a organization formed primarily by rich countries (Hanson, 2010). Nevertheless, growth remained sluggish thereafter.

It is worth noting that the reformist endeavour in Mexico was far from exception. Easterly (2019) presents updated stylised facts regarding what he named as policy outcomes. Using data on inflation, black market premium, negative real interest rates, currency overvaluation and extremely low trade shares from 1961 to 2015 the author shows some evidence that both extreme and moderate policy outcomes (for instance, high inflation) became less frequent or even nonexistent in recent years, although they were common place during the 1980's and early 1990's.

As macroeconomic stability became an everyday reality in most countries the focus of the economic research followed through and changed from macro to microeconomic distortions. In fact, the set of potential explanations for the Mexican stagnation in the last decades have centered on policies and institutions that may generate perverse incentives and distort allocative decisions causing productivity to decline. There appear to be certain agreement on the potential explanations for the Mexican stagnation as being a result of inefficient financial system, lack of contract enforcement and rigidities in the labor market (Kehoe and Ruhl, 2010). One major consequence of an inefficient financial market is to fail at channeling enough investment to high return firms while low return firms continue to receive too much investment. Additionally, they also mention inefficient bankruptcy procedures that led to a strong contraction of lending in the 1994-95 financial crisis in Mexico as an example of the lack of contract enforcement. Hanson (2010) add the risk of government expropriation as one of the reasons for the underdevelopment of the financial market in Mexico. The expropriation happened twice in the past, first time during the 1970's increasing the mandatory bank reserves up to 40% and the second in 1982 with a nationalization of the bank system.

In addition to the previous arguments, Hanson (2010) suggests other factors that might play a role, for instance, social policy and informality. On one hand, the pervasiveness of informality allow the survival of unproductive firms that would otherwise exit the market if it were to comply with the regulation and pay taxes accordingly. Moreover, informal firms that are productive choose not to grow in size in order to avoid taxes and labor benefits. On the other hand, social policy that aims to benefit informal workers with a different set of regulations relative to formal workers might generate incentives for informality and induce more investments in low productive informal firms.

Also, Kehoe and Meza (2011) and Hanson (2010) highlight the presence of nonmanufacturing monopolies in important sectors like electricity, telecommunications, petroleum extraction and transportation. After the privatization wave of the 1980's and early 1990's, Mexico ended up with a monopoly in the telecommunication which causes a high burden in terms of input costs. Nonetheless, the electricity market is served by state owned companies. It is important to keep in mind that although market power may have consequences for competitiveness of the Mexican production in the world market, its effect on misallocation generated by implied distortions would need that the exercise of the market power differ across sectors[1].

Interestingly, Algazi (2020) summarizes the aforementioned arguments for the Mexican stagnation as being a result of its social and economic environment defined by a set of policies and institutions that govern three "worlds": the entrepreneur-worker relations, the set of taxations and the market conditions. The author uses data from the Mexico's Economic Census carried in a five year interval from 1998 to 2013, which documents information on the universe of firms except the ones located in localities with less than 2500 inhabitants or without fixed premises, i.e., street stands. The author complements the Census information with Mexico's Employment Survey which provides some data on firms not considered in the Census. With these data, the author documents four main stylized facts about firm's productivity: first, most of the economy resources (i.e., capital and labor) are allocated to firms with non-salaried contracts (roughly, firms in which the contractual arrangement with workers does not include salary payments, but rather, share of profits, payments by unit produced or payment per tasks), and to firms with salaried contracts that are illegal - salaried firms that do not comply with regulations such as social insurance, labor and tax regulations - which are less productive. Second, the production is dispersed among small, less productive firms. Third, firm dynamics are such that low productivity firms enter the market and tend survive whereas high productivity firms tend to exit the market and the ones that survive do not grow. Lastly, the lack of creative destruction tends to increase the resource misallocation over time.

The author argues that the Mexico's economic environment above defined induced the productivity decline by creating incentives that strengthened misallocation. Also, the author rules out the lack of human capital accumulation as one potential explanation of the productivity decline since Mexico improved the average years of schooling and the quality of education during this period. In contrast to this paper, the author considers the firm dynamics as the main dynamic mechanism connecting growth (or lack of) to the static distortions. Finally, the author provides evidence of increasing misallocation during the period whereas, in this paper, misallocation initially increases but then declines after 2000, as we will see later in the results.

[1] One last argument for the Mexican stagnation is the recent competition with China in the U.S. market since the Chinese accession to the WTO in 2001 (Hanson, 2010). Although this might be relevant in potentially explaining the stagnation of the Mexican economy, it is less likely that it would generate more distortions in the domestic market which the main point of this article.

In light of these specific microeconomic arguments for the Mexican stagnation, we sought to build a general equilibrium growth model that could encompass in a general framework the impacts of static distortions on aggregate productivity and growth. In order to do so, we followed the indirect approach as surveyed in Restuccia and Rogerson (2017) by assuming theoretical distortions in the production of sectoral goods that result from policies and institutions of the type discussed above. In the model, static distortions connect to two main growth mechanisms: capital accumulation and exogenous technology adoption. While the former is a result of the market incentives summarized in the real rate of return on capital, the latter is exogenously induced by the increase in the measure of traded varieties domestically produced. The international trade allows countries to be exposed to the expansion of the world technological frontier and learn from it. This process of technology adoption that, ultimately, increases the number of tradable varieties internally produced constitutes the long term growth mechanism.

The vast majority of the research in misallocation have focused on the static impacts of a change in firm-level distortions on aggregate productivity - with a few exceptions discussed in the introductory section[2]. Nevertheless, the recent combination of macroeconomic stability and the focus on microeconomic frictions give rise to a need to understand the growth effects of these static distortions. The way the model in this paper fill in this gap is by building a bridge between the sectoral distortions and the growth mechanisms through the relative rate of return on capital. The key prediction of the model is that in the balanced growth path, in which all countries grow at the same rate, the profile of sectoral distortions in the economy determines the equilibrium rate of return on capital. Moreover, countries with less overall distortions will face a lower rate of return in the long run after capital had time to adjust and, consequently, will have higher output per worker.

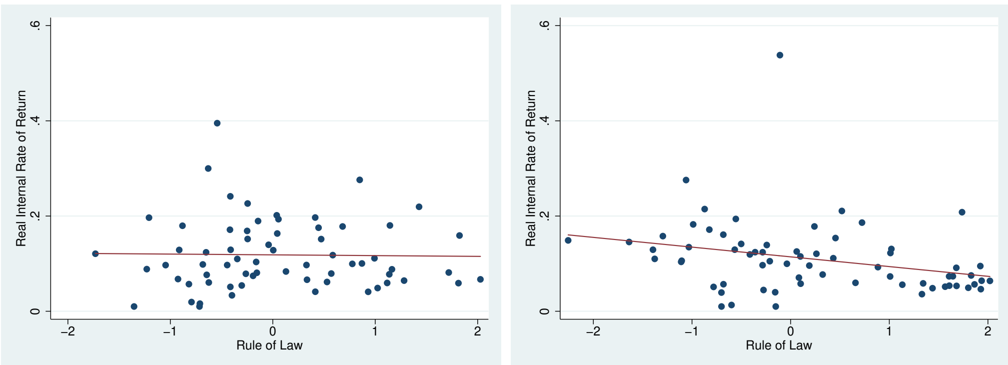
Figure 2 below seeks to empirically assess the central prediction of the model. Without making any claims on causality, Figure 2 depicts the real internal rate of return for all countries in the Penn World Table 9.1 in 2017 against the Worldwide Governance Indicator of "Rule of Law" calculated by the World Bank, as a rough measure of misallocation. These indicators are constructed based on several survey sources that reflect the views of the citizens, entrepreneurs, pundits in public, private and non-governmental organizations regarding Governance issues. We focus on the Rule of Law aggregate indicator that comprises individual indicators that fill in the following definition: *Rule of law captures perceptions of the extent to which agents have confidence in and abide by the*

[2]For comprehensive surveys in the topic the reader is referred to Hopenhayn (2014) and Restuccia and Rogerson (2017)

rules of society, and in particular the quality of contract enforcement, property rights, the police, and the courts, as well as the likelihood of crime and violence (Kaufmann et al., 2010). The choice of this indicator is due to the fact that it reflects the notion of the type of institutions and policies that may distort firm's decision making, for instance, regulations that spur informality, lack of contract enforcement and so on, as previously discussed.

As can be seen, for countries with below median GDP per worker growth rate in 2017 there is a negative relationship between the real internal rate of return and the misallocation measure, suggesting that the model prediction might find empirical support. In addition, it is import to highlight that the absence of relation among high growth countries is not against the model predictions since the negative relationship implied by the model is based on the balanced growth path equilibrium, that is, the long run behaviour and not during the transition that might be the case for the above median growth countries. Nevertheless, in the Appendix A Figure 8 depicts the same relationship between real rate of return and misallocation by GDP per capita growth rate which shows a negative relationship for both groups of countries.

Figure 2: Cross Country Real Internal Rate of Return and Misallocation in 2017 (by real GDP per worker growth rate)



(a) Above median growth (b) Bellow median growth

Finally, the model presented in the next section embeds the theoretical framework hypothesized by Kehoe and Ruhl (2010) and Kehoe and Meza (2011) without presenting the actual model. In their theory there is a constant growth in the stock of knowledge (interpreted as the U.S. long run growth of GDP per capita) which can be adopted at some cost. Without any policy or institutional reforms the country would essentially grow at the same rate of the frontier knowledge. Yet, convergence in the output per worker can be achieved through reforms in these policies and institutions to trigger a transition to a income level closer to the leading country. After institutional and policy changes cease and capital adjusts the country returns to the long run growth of the stock of available knowledge. As hypothesized by Kehoe and Ruhl (2010), countries with a poor set of policies and institutions leading to considerable distortions can still grow faster than countries closer to the leading economy as long as they are far behind. They argue that the difference between the growth of GDP per worker between Mexico and China rather than differences in the level of inefficiency of institutions and policies lay in the differences in the stages of development. This is exactly what the model presented in this sections implies and the reason is that the capital accumulation work as a short to medium run growth mechanism that respond to the profile of institutional environment. Since poor countries have inherently high returns to capital accumulation, small changes in the distortions' profile can trigger a substantial transition to a higher income level.

3 Model

This section outlines the open economy growth model with static distortions in the sectoral goods market. In each economy, there is a monopolistic competition between differentiated sectors that supply inputs to the homogeneous final good producers. Producers in each sector face specific distortions over their output prices that may affect the general equilibrium rate of return on capital accumulation, consequently changing growth incentives, whereas leading to aggregate total factor productivity (TFP) losses.

3.1 Preferences and Technology

3.1.1 Demographics and Preferences

Time is continuous. The world economy is populated by a continuum of countries $n \sim G(n)$. With a slight abuse of notation, n measures the mass of tradable intermediate varieties produced by a given country. Along with the assumption that each variety is produced by only one country, n is interpreted as the *degree of technological development*, in the sense that it reflects the differential technological capabilities between countries.

The representative household of country n supplies labor inelastically ($L_n = 1, \forall n$) and has preferences given by: (dropped the n subscript)

$$\int_0^\infty \exp(-\rho t) \log C(t) dt \tag{1}$$

The budget constrain is, in turn, given by: (dropped the t subscript)

$$p^Y \left(C + \dot{\bar{K}} + \delta \bar{K} \right) = r\bar{K} + w + \bar{\Pi} \tag{2}$$

where C is household consumption; $\bar{K}$ is household total capital holdings, which is the sum of capital across sectors; $\bar{\Pi}$ is total profits accruing from intermediate firms, which is the sum of profits across sectors; r and w are respectively, the rate of return on capital and the labor wage rate.

The transversality condition can be written as:

$$\lim_{t\to\infty} \bar{K}(t) \exp \left(- \int_0^t \left(\frac{r(v)}{p^Y(v)} - \delta \right) dv \right) = 0 \tag{3}$$

3.1.2 Technology

For each country n, there is a perfectly competitive final good market which uses differentiated products from S sectors as inputs, according to the following constant elasticity of substitution (CES) technology:

$$Y = \left(\sum_{s=1}^{S} y_s^{\frac{\sigma-1}{\sigma}} \right)^{\frac{\sigma}{\sigma-1}} \tag{4}$$

where $\sigma > 1$ is the elasticity of substitution between goods of different sectors. Also, firms in the final good market face prices p_s^y of inputs. Neither the final good nor the sectoral inputs are traded.

In each sector S, a differentiated product is produced by monopolistic competitive firms using capital and tradable intermediates in a Cobb-Douglas production function of the form:

$$y_s = z_s \chi K_s^{\alpha} X_s^{1-\alpha} \tag{5}$$

where z_s is the productivity in sector s, K_s is the demand for capital in sector s and X_s is the demand for tradable intermediate varieties. In turn, the tradable intermediate varieties are combined in a CES bundle given by

$$X_s = \left(\int_0^N x_s(\nu)^{\frac{\epsilon-1}{\epsilon}} d\nu \right)^{\frac{\epsilon}{\epsilon-1}} \tag{6}$$

where $x_s(\nu)$ is the demand for variety ν in sector s; $\epsilon > 1$ is the elasticity of substitution between intermediate varieties; and N is the total mass of varieties. Therefore, if we sum up all the measures of tradable varieties across countries we obtain N, that is, $\int ndG(n) = N$. Additionally, competitive firms hire labor in order to produce tradable intermediate varieties with a linear production function $x_s(\nu) = l_s(\nu)$. Finally, the constant χ is introduced for normalization.

Overall, growth in the above model are the result of two main mechanisms. The first one is capital accumulation, resulting from savings decision of the households and the demand for capital of firms in the differentiated products sectors. The second one is the exogenous technology adoption that comes through trade. There is an exogenous growth in the total mass of varieties at a rate given by $\dot{N}/N = \lambda > 0$. Trade between countries allows them to be exposed to frontier knowledge spillovers, in the sense that the mass o tradable intermediate varieties produced by each country also grows at the same rate as the technology frontier, that is, $\dot{n}/n = \dot{N}/N = \lambda$. Finally, there is no capital flow between countries which implies that trade balance must hold in all periods.

3.2 Households and Firms behaviour

Let us start with the final good producers decision. Since final good firms do not face any distortions both in input and output markets, their profit maximization problem yield the standard demand for sectoral products and the ideal price index given by:

$$y_s = \left(\frac{p^Y}{p_s^y}\right)^\sigma Y, \qquad p^Y = \left(\sum (p_s^y)^{1-\sigma}\right)^{\frac{1}{1-\sigma}} \tag{7}$$

In turn, the cost minimization problem for the differentiated products' firms given the technology (equations 5 and 6) implies the following unit cost function:

$$c_s(r, \tilde{P}) = \frac{1}{z_s} r^\alpha \tilde{P}^{1-\alpha} \tag{8}$$

where $\tilde{P}$ is the ideal price index of the tradable intermediate varieties, defined as:

$$\tilde{P} \equiv \left(\int_0^N p(\nu)^{1-\epsilon} d\nu\right)^{\frac{1}{1-\epsilon}} \tag{9}$$

The ideal price index is the numeraire in this world economy, consequently, it is normalized to one. Therefore, the unit cost function can be rewritten as $c_s(r) \equiv c_s(r, 1)$. Also, all values in the model can be interpreted as measured in units of the bundle of tradable intermediate varieties.

The differentiated products firms face the key decision in the model. Firms in each sector S, face a distortion τ_s over its output price. Taking as given its unit cost function and specific distortion, it chooses price in order to maximize profits given by:

$$\pi_s = \left[(1-\tau_s)p_s^y - c_s(r)\right] y_s \tag{10}$$

Profit maximization implies the standard optimal price, set as a markup over marginal cost:

$$p_s^y = \frac{\sigma}{\sigma-1}\frac{c_s(r)}{(1-\tau_s)} \tag{11}$$

Recall that from equation 8 and the above equation we have that revenue TFP, $p_s^y z_s$, - as it is called by Hsieh and Klenow (2009) and Foster et al. (2008) - is the same across sectors except for the distortion. It turns out, that this feature of the model will be key to identify the distortion as an implied ratio between import participation across sectors. The identification will be described in more detail in section 4 which focus on the calibration.

Equations 7 and the above equation combined imply that the output in each sector is a fraction of total output in the economy where the fraction is determined by the interaction between the sectoral productivity profile and distortions in a given economy. Thus,

$$y_s = \left(\frac{z_s(1-\tau_s)}{\left[\sum_{s'}\left(z_{s'}(1-\tau_{s'})\right)^{\sigma-1}\right]^{\frac{1}{\sigma-1}}}\right)^{\sigma} Y \tag{12}$$

Since firms producing the tradable intermediate varieties have a linear production function in labor and both its input and output markets are competitive, intermediate prices equal wages, $p(\nu) = w, \forall \nu \in n$.

It is useful to anticipate the market clearing conditions for exposition purposes. Since there is no capital flow, there must be trade balance in each period. Hence, one can derive the trade balance in the economy as:

$$\bar{X}_n = n p_n^{1-\epsilon} \int \bar{X}_{n'} dG(n') \tag{13}$$

where $\bar{X}_n = \sum_s X_{s,n}$ and $p_n = p(\nu) = w, \forall \nu \in n$ (See Appendix B.1 for the derivation). The trade balance condition can be interpreted as follows. Since each country is small in the world economy, the total sectoral demand for varieties comprises the total sectoral imports in the economy. Summing up across sectors we obtain the total imports for country n, the left hand side of the previous equation. The total exports, in the right hand side, requires a more cumbersome derivation. Nevertheless, an heuristic description is in place. The country n's exports comprises the world total demand for the intermediate varieties that are produced by the country, which is a fraction n of the world total expenditure in intermediate varieties divided by its price, taking into account the substitutability between varieties as summarized by ϵ.

The final market clearing condition is that of the labor market. By definition, the total inelastic supply of labor (normalized to one) equals total demand for labor. The demand for labor also results from the world demand for intermediate varieties produced in a given country n, due to the linearity of its production function. Accordingly, one can derive the labor market clearing as the following (See Appendix B.1 for the derivation):

$$1 = np_n^{-\epsilon} \int \bar{X}_{n'} dG(n') \tag{14}$$

In parallel with the trade balance reasoning, the above equation express world total demand for labor as a fraction n of the world total expenditure in intermediates divided by its labor price.

Now let us turn to the representative agent decision that is to maximize 1 subject to 2 and 3. The maximization problem yields a slightly different version of the traditional euler equation given by:

$$\frac{\dot{C}}{C} = \frac{r}{p^Y} - \delta - \rho \tag{15}$$

The new element is the presence of the final good price p^Y which appears normalizing the rate of return to capital accumulation. This formulation is quite natural due to the fact that the numeraire in the model is no longer the final good price, as in the standard neoclassical model, but instead the ideal price index of the tradable intermediate varieties bundle. It is worth noting that this form is key to the world balanced growth path (to be defined) with distortions that are country specific.

3.3 Equilibrium and Aggregation

The equilibrium in the world economy is defined as quantities and prices for each country such that firms maximize profits, consumers maximize utility and markets clear. Let us focus on balanced growth path equilibrium for the world economy, defined as an equilibrium in which consumption, and consequently output, grow at the same rate for each country n. The key challenge is the fact that the euler equation in standard neoclassical models would imply the same rate of return across countries in BGP. However, countries with different configuration of distortions between sectors would, ultimately, have different rates of return on capital and, consequently, there would be no BGP equilibrium. Therefore, the formulation in equation 15 allows for the possibility of the world BGP equilibrium whereas implying that differences in distortions across countries reflect in differences in the rate of return to capital and the final good price.

The next proposition shows the growth rate of consumption in the BGP world equilibrium. Let g_x be the growth rate of variable x in the BGP. Hence, we have the following result:

Proposition 1. *Consider the above described open economy neoclassical model with capital accumulation, exogenous technology adoption and the presence of sectoral static distortions. The long-run growth rate of total output, capital stock and intermediate bundle in the balanced growth path is given by:*

$$g_Y = g_{\bar{K}} = g_{\bar{X}} = \frac{1}{\epsilon - 1}\lambda \quad \forall\, n$$

Proof. See appendix B.3. □

The result shown in the above proposition is quite natural, since in the neoclassical growth models the long-run growth is usually driven by the exogenous growth rate of the world technological frontier captured by the parameter λ. Additionally, as it is the case in Acemoglu and Ventura (2002), the substitutability between varieties, ϵ, play an important role in determining long run growth but for different reasons. In the Acemoglu and Ventura's model ϵ determines the extent to which changes in relative income in a given country affect its terms of trade which, in turn, is related to the rate of return to capital. Therefore, in their world of AK economies, higher level of ϵ would imply a higher output growth rate needed to bring down the rate of return to capital through terms of trade and to ensure a common steady state growth rate for the world economy. In contrast, in the model presented here the substitutability parameter determines the degree of trade between countries and, as a result, the extent of technology adoption. In this sense, higher values of the ϵ means that all countries' varieties are highly substitutable and there is less need for trade and less opportunity of technology adoption that comes through international trade interactions. In the limit, $\epsilon \to \infty$ there is no long-run growth.

Now we are able to discuss how the sectoral distortions affect growth in this model. As it is clear from Proposition 1, the output growth rate in the balanced growth path is not affected by the distortions. However, both the transition and the long-run rate of return on capital are determined by them. The way to see this result is the following.

From Proposition 1 and the euler equation 15, it straightforward to see that the long-run ratio between the rate of return to capital and final good price is constant. Let us call this long-run ratio by the *actual rate of return* and denote its value by $(r/p^y)^*$. From equations 7, 8 and 11 we obtain the actual rate of return as:

$$\frac{r}{p^Y} = \frac{\sigma - 1}{\sigma} \mathcal{B} r^{1-\alpha} \tag{16}$$

where $\mathcal{B} \equiv \left[\sum_s (z_s(1-\tau_s))^{\sigma-1}\right]^{\frac{1}{\sigma-1}}$. The above equation shows that the BGP rate of return, r^*, is determined by the long-run actual rate of return as well as the aggregator of the profile of productivities and distortions across sectors. Accordingly, any increases in the aggregator would translate into decreases in r^*. Thus, assuming that the distortions are positive and less than one - as it is the case in the calibration - higher values for the sectoral distortions would distance the economy from the actual profile of productivities, decreasing $\mathcal{B}$ and increasing the rate of return in the BGP. This is one of the interesting features of the model, the ability to generate cross country differences in the rate of return in the BGP, as seen in the data, explained by differences in the sectoral distortions faced by them.

Another important implication of the model is how the sectoral distortions combine to affect the aggregate total factor productivity (TFP) in the economy. As we show in the appendix B.4, total output in each country n is given by:

$$Y = \frac{1}{\alpha} \mathcal{A} r^{1-\alpha} \bar{K} \tag{17}$$

where

$$\mathcal{A} \equiv \frac{\left[\sum_s (z_s(1-\tau_s))^{\sigma-1}\right]^{\frac{\sigma}{\sigma-1}}}{\sum_s z_s^{\sigma-1}(1-\tau_s)^{\sigma}} \tag{18}$$

Equation 18 presents two main implications of the model regarding the effect of the sectoral distortions on aggregate TFP. First, the sectoral distortions aggregate in a more intricate way, having a nonlinear effect on TFP. Second, while the average distortion have no effect on the TFP, its variance is important to determine the effect on aggregate productivity. In order to see that, suppose an increase in all distortions by a factor of $\gamma > 1$. This increase in the average distortion would have no impact on $\mathcal{A}$, although the BGP rate of return would be affected. Guided by this relationship between distortions and the aggregate TFP, one of the counterfactuals implemented in Section 5 is to use the Mexican distortions in the year with highest dispersion to assess the strongest impact of changes in the sectoral distortions on the aggregate output and on the incentives to accumulate capital relative to adopt technology in the economy. More details on the counterfacuals are given in section 5.

Although the model have already been fully presented, it is important to anticipate the expressions for the moments used in the calibration section that were not presented so far. The first is the sectoral participation in total output given by:

$$\frac{p_s^y y_s}{p^Y Y} = \frac{[z_s(1-\tau_s)]^{\sigma-1}}{\sum_{s'}[z_{s'}(1-\tau_{s'})]^{\sigma-1}} \tag{19}$$

which only depends on the productivity profile and distortions across sectors.

The last expression is the import participation across sectors, given by:

$$\frac{X_s}{p_s^y y_s} = (1-\alpha)\frac{\sigma-1}{\sigma}(1-\tau_s) \tag{20}$$

The above equation shows that the import participation in sector s depends on parameters common to all sectors and the sector specific distortion. As already mentioned, this formulation allows to recover the distortions directly from the data.

4 Data and Calibration

In this section, the databases used are briefly presented along with the calibration strategy as well as the counterfactuals performed.

The main data used is the World Input-Output Tables Release 2013 which provides a panel of 40 countries and a "rest of the world" additional country, through 1995 to 2011 disaggregated into 35 sectors[3]. The Input-Output tables provide a measure of the linkages between sectors within and between countries. Moreover, they are constructed based on the official nationals Input-Output tables as well as information on national accounts. The choice of the Release 2013 is due to a higher length of period covered - 17 years as opposed to 15 years in the Release 2016 - and the starting year of 1995, since it is closer to the beginning of reforms in Mexico after the crisis faced by the economy during the 80's.

Another source of data is the Penn World Table (PWT) 9.1, which is a panel of 183 countries throughout 1950-2017 comprising national accounts type of data, for instance, gross domestic product both the expenditure and output side, capita stock, components of the aggregate demand, population as well as the exchange rate that takes into account

[3]See Timmer et al. (2015) for more details on the World Input-Output Database project.

differences in the purchasing power parity across countries. Data on real internal rate of return and capital-output ratio for Mexico in the 1995-2011 period, obtained from the PWT, are among the data moments used in the calibration[4].

With these databases in mind, the next step is to describe the calibration strategy for the model economy. Let us begin with the sectoral distortions. From equation 20, it is straightforward to see that the ratio of import participation between two sectors, say s and s', only depends on the ratio of their respective distortions as follows:

$$\frac{X_s/p^y_s y_s}{X_{s'}/p^y_{s'} y_{s'}} = \frac{1-\tau_s}{1-\tau_{s'}} \tag{21}$$

In the above ratio of import participation the common component across sectors cancel out and only the sector specific determinant of the demand from varieties remains. Moreover, it does not depend on the sectors' productivities which follows from the fact that the revenue TFP in each sector, $p^y_s z_s$, also only depends on the distortions.

Using the Input-Output data on import participation by sector it is possible to recover all the distortions but one. As discussed in the previous section, the normalization of the distortions relative to one specific sector would not affect the aggregate TFP of the economy but it would matter for the BGP rate of return on capital. Consequently, the import participation in each sector is normalized relative to the sector with the highest import participation - implying that all distortion values lay within the zero-one interval - and its distortion is calibrated to match the BGP rate of return to capital.

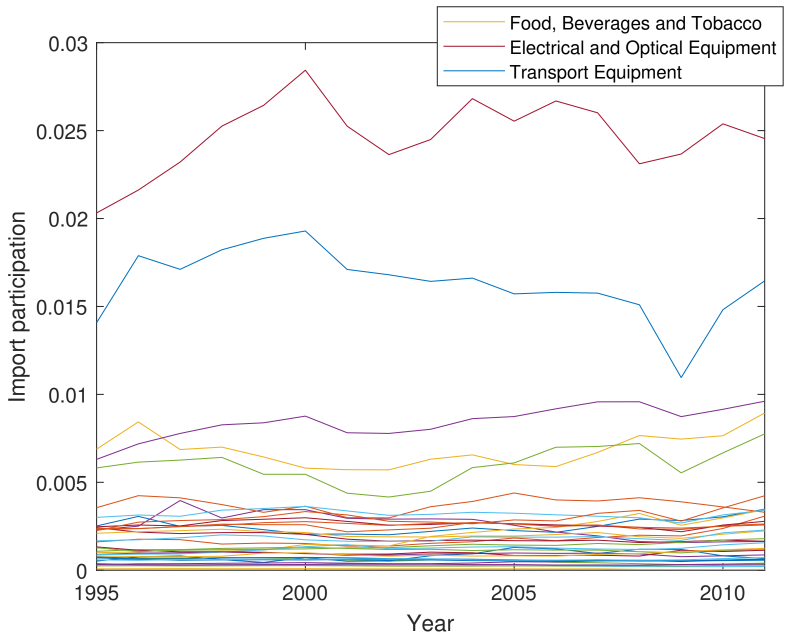
In order to get a sense of the import participation by sector in the data, Figure 3 depicts the data from the WIOT for the Mexican economy. Some of the empirical patterns are worth noting. First, there is some degree of cross sector and time variation in the import participation, although for most of the sectors the import participation is somewhat stable throughout the period. Second, most of the sectors have a low import participation in sectoral GDP (below 0.5%) and remain low throughout the period. Third, some sectors exhibit a clear trend in spite of small short run shocks[5]. Those patterns are important for the measure of distortions recovered from the data, in the sense that the variance of import participation reflects on the variance of the distortions across sectors and, ultimately, determine the aggregate productivity whereas its average discipline the highest import participation sector's distortion in matching the BGP's rate of return. Later in this section, the assumption that the distortions can be recovered

[4] An interested reader is referred to Feenstra et al. (2015) for more details on the PWT data.

[5] The high import participation sectors in decreasing order for 1995 are 'Electrical and Optical Equipment', 'Transport Equipment', 'Food, Beverages and Tobacco', 'Construction', 'Basic Metals and Fabricated Metal'.

from the sector's import participation decision is discussed in more detail.

Figure 3: Sectoral Import Participation for Mexico in 1995-2011



The next step is to calibrate the model given the distortions recovered directly from the data. Ideally, the calibration strategy could try to recover the changes in the sectoral productivities starting from a initial BGP of the economy from the observed pattern of output growth. However, this is not feasible since there is only one path of output growth and many sectoral productivities. Therefore, the strategy adopted here calibrates the BGP of the model for the initial and final years of the data, respectively, 1995 and 2011. The first set of parameters $\{\delta, \epsilon, \lambda, \sigma\}$ are externally calibrated. The annual depreciation rate is set to $\delta = 0.05$ as is standard in the literature. The elasticity of substitution between varieties, ϵ, and the growth rate of the technological frontier λ are set in order to match the U.S. hundred years annual GDP per capita growth rate of 1.8%, as the world technological frontier, taking values of $\epsilon = 2$ and $\lambda = 0.018$. Note that the parameter ϵ has no effect on either the aggregate productivity nor the BGP rate of return on capital, rendering this normalization innocuous. The elasticity of substitution between sectors is set to $\sigma = 3$ following Hsieh and Klenow (2009).

Another set of parameters are internally calibrated exploiting 72 data moments for 72 parameters. The set of calibrated parameters is given by $\{\alpha, \rho, \tau_s^{1995}, \tau_s^{2011}, \{z_s^t\}_s^t\}$. Let us begin with the distortions, once again. These are the distortions for the sector with the highest import participation used to normalize all the distortions, as discussed above. Since the highest participation distortion has a direct impact on the BGP rate of return on capital, the geometric mean of the real internal rate of return over a previous period of the same length (1979-1995) is used to capture the long run behaviour of the rate of return on capital and discipline the parameter in the initial year. Analogously, the highest participation distortion in the last year is disciplined by the real internal rate of return in 2011. Now, the share parameter, α, is disciplined by the mean aggregate output to capital ratio over a previous period of the same length (1979-1995) - again, to free the the output to capital ratio up from short run fluctuations - since it directly determines the total capital-output ratio. The intertemporal rate of substitution, ρ, in turn, is disciplined by the final year aggregate output to capital ratio, which indirectly reflects the long-run equilibrium in the economy. Finally, as equation 19 shows, the sectoral productivities directly determine the sectoral participation in total GDP once the distortions are controlled for. Thus, the data counterparts of the sectoral participation discipline all the 34 sectoral productivities in both the initial and final years[6].

Table 1 summarizes the externally calibrated parameters and a selected subset of the calibrated parameters for the Mexican economy, leaving the sectoral productivity parameters for the Appendix C.1. As can be seen, the value of the parameter of the sectoral Coob-Douglas production function, α, is close to half, which seems reasonable since there are profits in the model accruing from the monopolistic competition in the sectoral production, as opposed to standard calibrations of the parameter that only take into account wage and capital share in total GDP. Moreover, the intertemporal substitution parameter, ρ, is calibrated to a annual value of 0.3 that is higher than the usual figures. It seems reasonable to conjecture that this value is related to the method used to guarantee the convergence of the simulation of the transition that is explained later in this section.

It is important to emphasize the nature of the calibrated distortions. As pointed out in the beginning of this section, the ratio of distortions between sectors are retrieved directly from data. Therefore, one can normalize the ratios by one sector specific distortion. In this calibration, the distortion of the sector with the highest import participation in the initial year 1995 (it is also the highest import participation throughout the sample period) is calibrated and its distortions used to normalize the ratio of distortions between sectors. The calibrated distortion of the sector with highest import share in

[6]The sector c35 "Private Households with Employed Persons" is excluded from the analysis due to the fact that its import participation is nearly zero and that would imply the maximum possible distortion of one. Although the distortions are recovered from data (actually, calibrated for one of the sectors) based on the assumption that variations on the import participation reflects variations in the distortions, it is unlikely that a sector with a distortion of one would still produce.

the initial period for 1995 is 0.3 and its value goes down to less than half (0.14). As our previous discussion suggests, although this decrease does not affect the aggregate productivity it does affect the economy wide interest rate in the BGP, implying a drop in the output price and a consequently increase in the actual rate of return, inducing capital accumulation and a later decrease in the interest rate. Thus, the calibration implies that a decrease in the calibrated distortion is needed in order to account for the decrease in the interest rate observed in the data. Ultimately, the effect on the BGP interest rate depends on the changes in all distortions. Furthermore, one important issue in the misallocation literature is how productivities and distortions are related. Since this correlation is central to the literature, a more in depth discussion of the productivity parameters and how they relate to the sectoral distortions is left to Section 5.

Table 2 shows the model fit for selected targets that characterize the Mexican economy in both the initial and final calibrated years. The model fit of the sectoral participations in total GDP is left to the Appendix C.2. Overall, the model is able to replicate fairly well the main targeted features of the Mexican economy in the period, specially in the final period. The model somewhat overestimates the output-capital ratio whereas it moderately underestimates the observed real internal rate of return, both in 1995. Given the simplicity of the model, it seems to fit the observed data reasonably well.

Finally, in terms of the exercise implemented in this paper, the model transition is simulated from the initial calibrated BGP in 1995 towards its final BGP in 2011 with the exogenous change coming from the variation in the distortions and the calibrated productivities between both years. In order to obtain a reasonable convergence of the transition simulation we subdivide the time unit (a year, in this case) in subperiods (=24) and run the model over all periods. Hence, all the annual rates - depreciation, intertemporal discount rate and the growth rate of the measure of varieties - are subdivided by the number of periods to obtain the equivalent rates. The annualized results are then reported for the benchmark calibration in which both sectoral productivities and distortions vary between the initial and final periods as well as the counterfactuals that keep each at a time constant. The next section provides the details of those exercises.

5 Results

This section describes the main results of the paper. The primary goal of this section is to improve our understanding of how changes in static distortions affect the growth mechanisms in the model, that is, capital accumulation relative to technology adoption. It begins by presenting the benchmark calibration results for the long run equilibrium

Table 1: STRUCTURAL PARAMETERS CALIBRATED VALUES FOR THE MEXICAN ECONOMY

(a) Panel A

Externally Calibrated		
Definition	Parameter	Value
Depreciation rate	δ	0.05
Elast. of subst. (varty)	ϵ	2.00
Tech. front. growth rate	λ	0.018
Elast. of subst. (sector)	σ	3.00

(b) Panel B

Internally Calibrated			
Definition	Parameter	Value	Target
Share parameter	α	0.46	Output-capital ratio (1979-95)
Intertemporal discount	ρ	0.30	Output-capital ratio (2011)
Distortion 1995 ($s =$ max import)	τ_s^{1995}	0.30	Real rate of return (1979-1995)
Distortion 2011 ($s =$ max import)	τ_s^{2011}	0.136	Real rate of return (2011)
Sectoral productivity	$\{z_s^t\}_s^t$	–	Sectoral participation in GDP

Notes: The table shows the externally and internally calibrated parameters, their values and the targets that potentially discipline them in the calibration for the Mexican economy. In Panel 1a, the annual depreciation rate is set by the author. The elasticity of substitution between varieties and the growth rate of the total mass of varieties are set to match the long-run annual growth rate of GDP per capita for the US. The elasticity of substitution between sectors is taken from Hsieh and Klenow (2009). In Panel 1b, the simple mean of the output to capital ratio and the geometric mean of the real internal rate of return in the period 1979-1995 are calculate from data in the PWT 9.1 in order to capture the long-run pre sample behaviour of these variables. The sectoral participation in total GDP for the Mexican economy is calculated from the WIOT Release 2013. The calibrated sectoral productivities parameters are presented in Table 8 and Table 9 in the Appendix C.1.

and the transition starting from the initial calibrated BGP towards the final BGP equilibrium in which sectoral productivities and distortions vary at the same time. Also, the important issue of the correlation between sectoral productivities and distortions is discussed with some level of detail. Next, the subsection dedicated to the counterfactual analysis outlines a series of exercises that keep either sectoral productivity or distortions constant each at a time, and the final exercise that uses the distortions recovered from the sectoral import participation in 2000, the year with highest dispersion of import participation which translates into high dispersion of distortions. This last exercise aims

Table 2: Model Fit of the Targeted Moments for the Mexican Economy

	1995		2011	
Moments	Model	Data	Model	Data
Output-capital ratio	0.34	0.31	0.26	0.27
Real rate of return	0.13	0.15	0.13	0.13

Notes: The table shows the model fit of selected targeted moments for the Mexican economy. The output to capital ratio is calculated from data in the PWT 9.1 and averaged between the period 1979-1995. The real internal rate of return in the period 1979-1995 is also averaged using the geometric mean. These averages aim to capture the long-run pre sample behaviour of the economy.

to capture the worst case scenario in terms of data implied distortions and its impact on the long run equilibrium. Lastly, we present more disaggregated results of a sector by sector ten percent decrease in the distortions and its effect on long run aggregate output.

5.1 Long-run and Transition Effects

The first result is a comparison between the aggregate endogenous variables in the balanced growth path equilibrium calibrated for the Mexican economy in 1995 and 2011. Taking the data implied sectoral distortions as given, the sectoral productivities are calibrated to match salient features of the economy in the period. Thus, the final BGP calibrated equilibrium takes into account the long run effects of changes in the profile of distortions and productivities in each sector on the incentives for capital accumulation relative to technology adoption. These effects are summarized in Table 3.

In the BGP, all aggregate variables grow at the same rate given by Proposition 1. Hence, the aggregate output, aggregate capital and consumption were normalized by the total country imports, rendering them stationary in equilibrium. Also, Table 3 shows the value of the endogenous variables in 2011 relative to the initial BGP equilibrium in 1995 for the variables with value equal to one in the initial year.

The benchmark calibration implies a drop in the normalized aggregate output and consumption of roughly 23% with a slightly higher decrease in consumption. However, aggregate capital increases. Therefore, the output-capital ratio decreases from 34% to 26%. This differential response of capital relative to output has its roots on the differential effect of changes in the profile of sectoral distortions on the aggregate total factor productivity (TFP), $\mathcal{A}$, compared to its effect on the price composite of productivities and distortions $\mathcal{B}$. While the former drops by roughly the same as the aggregate output

Table 3: NORMALIZED ENDOGENOUS VARIABLES FOR THE MEXICAN ECONOMY

Benchmark BGP relative to 1995		
	1995	2011
Aggregate Output	1	0.76
Aggregate Capital	1	1.006
Consumption	1	0.76
Output-capital ratio	0.34	0.26
Output price, p^Y	1	0.99
Internal rate of return	0.1365	0.1357
Aggregate import share	0.050	0.066
Aggregate capital share	0.39	0.51
$\mathcal{A}$	1	0.76
$\mathcal{B}$	1	1.0031

Notes: The table shows the value of the normalized endogenous variables in the benchmark calibration's balanced growth path. Each endogenous variable is normalized by the total imports, rendering them stationary in equilibrium. Also, the table shows the value of the variables relative to their BGP equilibrium in 1995 for variables with value equal to one in the initial year.

the latter slightly increases.

In order to clarify the implications of these differential movements of sectoral productivities and distortions composites let us go back to some of the model equations. Recall from equation 17 that changes in the sectoral profile of distortions and productivities have a direct effect on the aggregate output of the economy. Thus, a change in the sectoral distortions and productivities that combined generates a decrease in the aggregate TFP would lead to a drop in the aggregate output even if total capital remains constant. This effect is well documented in the misallocation literature (Restuccia and Rogerson, 2008; Hsieh and Klenow, 2009). However, there is another effect of changes in sectoral distortions and productivities that has dynamic implications. Equation 16 implies that theses changes have a potentially different effect on the actual rate of return. Indeed, in the benchmark calibration the price composite slightly increases inducing capital accumulation at a rate higher than the technology adoption that counteracts the initial drop in the aggregate output. Hence, leading to capital deepening, that is, a decrease in the output-capital ratio that is not motivated by sectoral productivities increases.

This is the key result of the model and contrasts it with the standard neoclassical growth models. In those models changes in the aggregate TFP impact both the aggregate output and the economy wide interest rate in the same direction. Therefore, the static and the dynamic effects are qualitative similar. In the model presented in this paper these effects are potentially disconnected and the reason is that the profile of sectoral distortions affects the final output prices in a different direction than it affects the aggregate TFP. As Table 3 shows, changes in the profile of sectoral productivities and distortions lead to an increase in the price composite, that implies a mild decrease in the output price. Since the dynamics of the model is also driven by the euler equation (equation 15) the increase in the actual rate of return triggers capital accumulation to a higher extent relative to the technology adoption despite the decrease in the aggregate TFP.

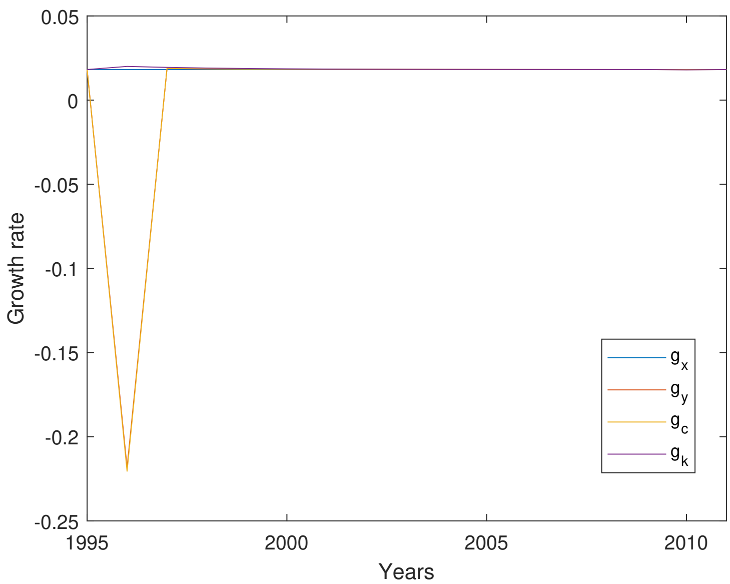
It is worth noting that this differential impact of changes in the profile of sectoral distortions on the aggregate TFP and prices, which ultimately impact the growth mechanisms, have important policy implications. If some of these changes in distortions are policy driven decisions by the government it could lead to the misguided impression of success. The way to see this is interpreting the normalized aggregate output as being measured relative to the leading country's aggregate output, since the imports grow at the same rate as the stock of frontier knowledge, which here is calibrated to the U.S. long run growth rate. Once the policy driven changes in the distortions hit the economy, the prices responses to the policy could generate capital accumulation that surpass the technology adoption even if it, in fact, increases the sectoral distortions in the economy and lower the aggregate TFP. This would trigger growth in the aggregate output through time that would be lower from what would have been if distortions were mitigated instead. In the concluding section we return to the issue of policy implications of the model.

Next, the transition of the model is investigated through a simulation of a shock in the profile of sectoral productivities and distortions between the initial calibrated BGP in 1995 and the final calibrated BGP in 2011. It is assumed that the economy begins at the initial BGP equilibrium in 1995 and then faces a one time permanent shock in the sectoral productivities and distortions in the following period, after which the endogenous variables adjust towards the new BGP equilibrium with productivities and distortions given by their calibrated values in 2011.

Figure 4 shows the behaviour of the growth rate for the aggregate output, aggregate capital, consumption and total imports. After the shock the growth rate of aggregate output and consumption drop significantly by roughly the same magnitude and then increase to a value slightly higher than the growth rate of the technology adoption reflected in the total imports growth rate. The differential impact of the shock in the profile of sectoral productivities and distortions in the aggregate TFP (the static effect) and in the actual rate of return (the dynamic effect) give rise to an increase in the capital accumulation rate that exceed the rate of technology adoption despite the decrease in the productivity. As already mentioned, this price response leads to a rather small compensatory increase in the aggregate output through time that is not driven by productivity increases. Thus, the output-capital ratio decreases along with the economy interest rate.

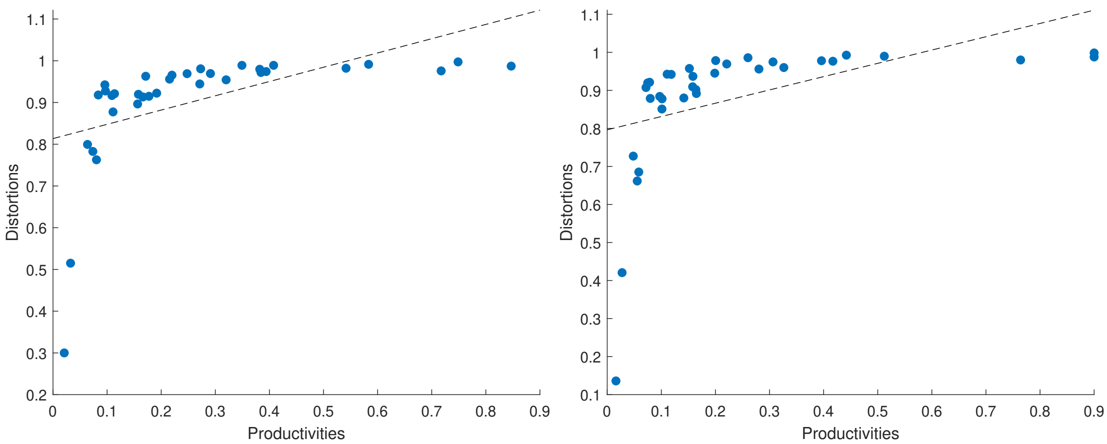
It is worth emphasizing that the qualitative differences in the static versus the dynamic effect of the shocks in the sectoral profile of productivities and distortions generate new implications for the total effect on the aggregate variables and constitutes the main message of the model. Additionally, it is also important to ask how the responses would change if either sectoral productivities or distortions remain constant. Although, this question is postponed to the next subsection, it is clear from equation 18 that the aggregate TFP, $\mathcal{A}$, would equal the price composite, $\mathcal{B}$, in the absence of sectoral distortions. Hence, the presence of sectoral distortions is crucial to give rise to differential static versus dynamic effects.

Figure 4: Transition Growth Rates for the Benchmark Final BGP



The aggregate effects of changes in the profile of sectoral productivities and distortions hide the heterogeneous changes across sectors emphasized by the literature. One important issue in the misallocation literature is the degree of correlation between sectoral productivities and sectoral distortions. For instance, Restuccia and Rogerson (2008) consider the case of correlated idiosyncratic distortions when assessing the static effects of changes in the distortions and Bento and Restuccia (2017) highlights the dynamic effects of changes in the empirically observed correlation between productivities and distortions on the productivity distribution. In order to gauge the correlation between the calibrated sectoral productivities and distortions Figure 5 depicts the scatter plot of the sectoral distortions against the sectoral productivities in both the initial and final BGP calibrated equilibria. There is a positive correlation between sectoral productivities and distortions in the Mexican economy in both years. In particular, the calculated correlation is considerable, around 0.5119 in 1995 but it decreases modestly down to 0.4587 in 2011. As it will be clear in the counterfactuals the decrease in the overall sectoral distortions is responsible for the increase in the price composite of sectoral productivities and distortions which induces capital accumulation in excess of technology adoption. Nevertheless, the correlation between productivities and distortions does not change much which results in the lower aggregate TFP in the final BGP.

Figure 5: Correlation Between Sectoral Productivities and Distortions



(a) Correlation in 1995 (b) Correlation in 2011

The changes in the profile of sectoral productivities and distortions between the initial and final BGP equilibria were considerably heterogeneous. Figure 6 depicts three main correlations that help visualize the heterogeneous sectoral variation between BGPs: the first two panels, Panel 6a and Panel 6b, depict the correlation between initial productivities and the change in productivities and distortions, respectively, and Panel 6c shows the correlation between changes in productivities and changes in distortions. The vast majority of the sectors experienced a decline in the calibrated productivities between

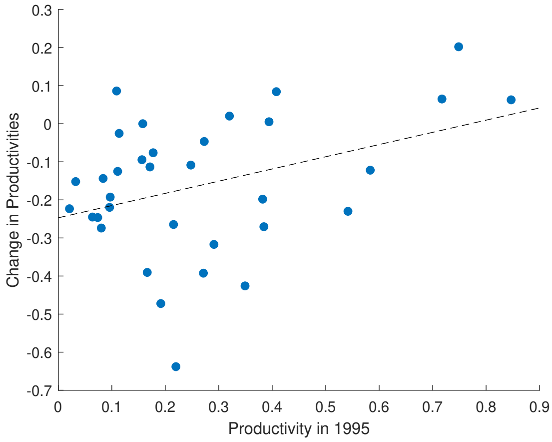
1995 and 2011. Also, sectors with low initial productivities experienced stronger decline in productivity whereas the initially high productivity sectors experienced an increase in productivity. However, the change in distortions did not substantially declined the correlation between productivities and distortions. As Panel 6b shows the sectors with low initial productivity (which had the strongest decline in productivity) also experienced the strongest decrease in the sectoral distortions. Although most of the sectoral distortions fell during the period, there is a positive relation between initial productivity and changes in the distortions preserving the level of correlated distortions. The last panel make this point clear by showing a positive correlation between changes in sectoral distortions and changes in sectoral productivities. Overall, the sectoral productivities and distortions declined between the initial and final BGPs in a way that preserved the correlated distortions roughly the same in the Mexican economy. The next subsection presents the counterfactual impacts of changes in the set of sectoral productivities and distortions, each at a time, on the endogenous variables.

5.2 Counterfactual Productivities and Distortions

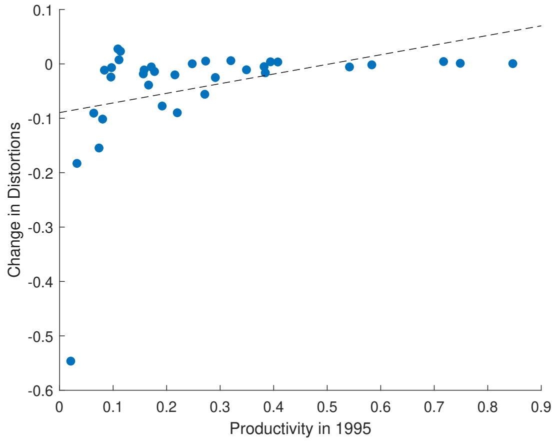
In this section, some counterfactuals are explored to improve further our understanding of the long run effect of static distortions. In particular, the isolated effect of changes in either sectoral productivities or distortions are investigated. Three main counterfactual exercises are conducted. In the first counterfactual the sectoral distortions remain constant at their level in 1995. The second counterfactual maintain the sectoral productivities constant at the initial period level. In the last set of counterfactuals a different profile of sectoral distortions is used. Specifically, the relative sectoral distortions are recovered from data in 2000. In this year the dispersion of the import share reaches its maximum implying the maximum dispersion of sectoral distortions (See Figure 9 in the Appendix). Therefore, by using the sectoral distortions from 2000 one can assess its effect on the long run BGP equilibrium for the Mexican economy in a worst case scenario if it was to maintain the absolute and correlated level of the sectoral distortions in 2000 implied by the empirical data. Recall that the relative sectoral distortions are recovered from the data and the distortion of the sector with the highest import participation, which is used to normalize the distortions, is calibrated in the initial and final BGPs. Since we cannot recovered its value in 2000, the counterfactual conducted here uses first the distortion of the highest import participation in 1995 as the normalizing distortion and later it uses its value in 2011 as the normalizing distortion.

Table 4 presents six different counterfactuals for the Mexican economy. All the

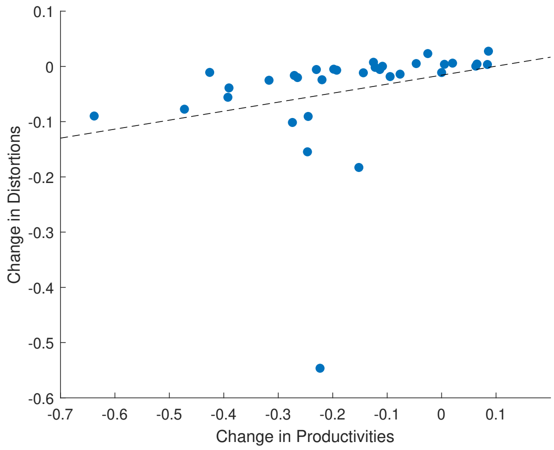
Figure 6: Initial Sectoral Productivities and Change in Productivities and Distortions in 1995 and 2011



(a) Change in Productivities



(b) Change in Distortions



(c) Change in Productivities and Distortions

values of the endogenous variables are normalized by the total imports as before. Also, the values are presented relative to their BGP level in the initial year. The first two columns simply replicate the benchmark results of Table 3 for convenience. Columns 3 and 4 show the results for the first two counterfactuals. The former shows that in the absence of changes in the distortions, the aggregate output would have declined around 21% in 2011, the aggregate capital roughly 27% and consumption approximately 21%. Contrary to the benchmark calibration, the output-capital ratio would have instead increased. And the reason is that the aggregate TFP and the price composite decline as a result of the drop in the sectoral productivities documented in the previous subsection. Thus, the output price increases reducing the actual rate of return on capital generating a decrease in the capital accumulation relative to the technology adoption. In contrast to the benchmark final BGP the import share decline while the capital share increases by almost as much as in the benchmark final BGP.

In turn, Column 4 shows the counterfactual BGP equilibrium when the sectoral productivities remain constant. A completely opposite behaviour of the endogenous variables comes out. As described in the previous section most of the sectoral distortions decreased in the period. Consequently, the counterfactual aggregate output, the aggregate capital and consumption increases significantly relative to the initial benchmark BGP. The aggregate capital increases by 74% while aggregate output and consumption increases around 32%. The output-capital ratio remains fairly constant whereas the aggregate import share and capital share increases relative to the initial benchmark BGP. The reason for the increase in the aggregate output is twofold. First, there is a mild increase in the aggregate TFP of 2.35% which directly increases aggregate output (the static effect). Second, there is a substantial increase in the price composite (approximately 34%) that decreases final output prices, leading to an increase in the actual rate of return on capital that induces stronger capital accumulation relative to technology adoption which, finally, amplifies the initial increase in output (the dynamic effect). Note, however, as the economy adjusts to the new BGP equilibrium the economy wide interest rate decreases substantially by almost 6 p.p. in the final BGP.

The transition for the first two counterfactuals are analysed in Figure 7. As can be seen, Figure 7 depicts the growth rates of the aggregate output, the aggregate capital, the aggregate consumption and total imports. Figure 7a shows the effect on the growth rates when the distortions remain constant at their level in 1995. As already discussed there is a decline in sectoral productivities in the period that leads to a strong negative response of growth rates. Note, however, that the response of the capital accumulation is less severe than the response of aggregate output and consumption growth. In contrast, Figure 7b shows a completely different behaviour of the growth rates. Since sectoral distortions declined in the period - although the correlation between distortion and productivities did not decreased much - the counterfactual growth rate of output shows a substantial increase relative to the growth rate of technology adoption which is induced by the strong increase in the price composite as already discussed. Again, all aggregate outcomes exhibit the same qualitative positive response, though the magnitude of the capital accumulation response is higher[7]. Finally, the depicted growth rate responses to

[7]The magnitudes of the response are somewhat extreme, however in this exercise all the impact of decade long changes in sectoral productivities and/or distortions are concentrated in one year, which explains at least partially the magnitudes. Also, the model embeds only two out of a number of growth

Table 4: NORMALIZED ENDOGENOUS VARIABLES FOR THE MEXICAN ECONOMY

Counterfactual BGP relative to 1995								
					τ_s^{2000} init		τ_s^{2000} final	
	1995	2011	τ_s init	z_s init	z_s init	z_s final	z_s init	z_s final
Aggregate Output	1	0.76	0.79	1.32	0.61	0.43	0.74	0.52
Aggregate Capital	1	1.0058	0.72	1.74	0.66	0.45	0.99	0.67
Aggregate Consumption	1	0.76	0.78	1.32	0.61	0.43	0.74	0.52
Output-capital ratio	0.34	0.26	0.37	0.26	0.31	0.33	0.25	0.26
Output price, p^Y	1	0.99	1.38	0.57	1.49	2.18	1.0079	1.47
Internal rate of return	0.1365	0.1357	0.18	0.078	0.20	0.29	0.13	0.20
Aggregate import share	0.05	0.066	0.046	0.067	0.055	0.053	0.068	0.065
Aggregate capital share	0.39	0.51	0.50	0.29	0.63	0.89	0.53	0.74
$\mathcal{A}$	1	0.76	0.91	1.023	0.74	0.63	0.74	0.63
$\mathcal{B}$	1	1.0031	0.83	1.34	0.80	0.65	0.99	0.81

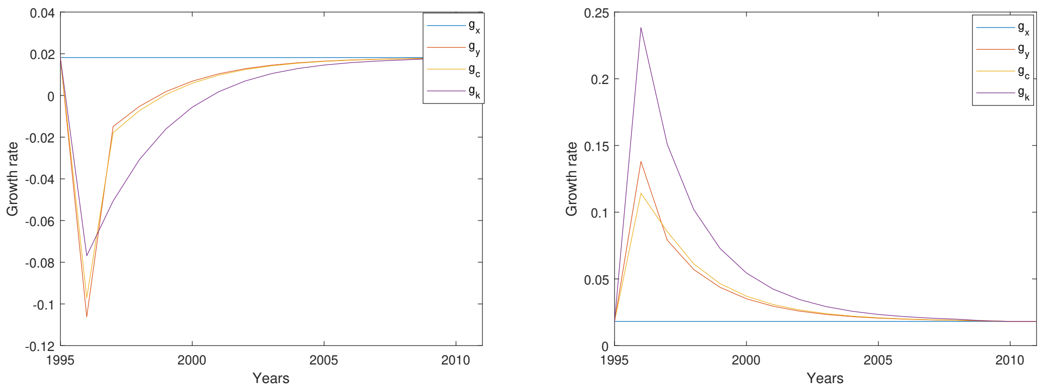
Notes: The table shows the value of the normalized endogenous variables in the balanced growth path for counterfactual exercises. Each endogenous variable is normalized by the total imports, rendering them stationary in equilibrium. Also, the table shows the calculated variables relative to the 1995 BGP for variables with value equal to one in 1995. The first two columns only replicates the results in Table 3. Columns 3 and 4 show the calculated counterfactual endogenous variables in the BGP keeping distortions constant and the calibrated productivities constant at the 1995 level, respectively. Columns 5 and 6 show the counterfactual results using the distortions recovered from data in 2000 and normalized by the initial level of distortion of the sector with highest sectoral import participation. Column 5 keeps productivity at the 1995 calibrated level whereas Column 6 also changes the calibrated productivity to the 2011 level. Columns 7 and 8 show the counterfactual results analogous to columns 5 and 6, using the distortions recovered from data in 2000 but normalized by the final level of distortion of the sector with highest sectoral import participation, instead.

the unanticipated shocks are exactly those expected in the standard neoclassical model in which the aggregate TFP affects both the total output and the actual rate of return in the same direction.

The last set of counterfactuals uses the sectoral relative distortions recovered from the data on import participation in 2000, the year with the highest dispersion of import participation and, consequently, higher dispersion in the sectoral distortions. Columns 5 and 6 show the case where the calibrated distortion for the sector with highest import share in 1995 is used to normalize all the distortions. The former column shows results where the sectoral productivities are constant at the 1995's level, while the latter allows

mechanisms at play in the data which may force greater responses in order to account for the observed empirical behaviour.

Figure 7: Transition Growth Rates for the Counterfactual Final BGP



(a) Distortions constant in 1995

(b) Productivities constant in 1995

the productivities to change to their final level in 2011. Column 5 shows that the effect of keeping the distortions at their implied 2000's value in the long run would decrease even more the aggregate output than the actual level of distortions in 2011. The decrease in the aggregate output and consumption would amount to almost 40% while the aggregate capital would fall by 33%. Output-capital ratio would then increase to 31%, the annual interest rate would reach almost 20% while the capital share would increase and the aggregate import share would decrease relative to their benchmark final BGP level. All this drop in the aggregate outcomes reflects the sizeable decline in the aggregate TFP and a relatively smaller decline in the price composite. The difference in the response of the aggregate TFP relative to the price composite dictates the magnitude of the static versus the dynamic effects.

Column 6 shows an even starker impact of changes in both the sectoral distortions (to their data implied value in 2000) and the sectoral productivities (to their calibrated final BGP level). The combined effect of the decline in productivity along with the sectoral distortions for the year with greatest dispersion would decrease the normalized aggregate output and consumption by as much as 56% while the normalized aggregate capital would decrease by a slightly lower figure of 54%. The output-capital ratio would remain fairly stable declining by 1.4p.p. while the output price would more than double, increasing by 120%, and the annual interest rate would reach 29.78%. Also, the aggregate import share and would mildly increase whereas the capital share would increase by more than 50 p.p. In this worst case scenario the aggregate TFP and the price composite would plummet by 37% and 34%, respectively.

Finally, the last two columns present the counterfactuals using the same sectoral relative distortions recovered from the data on import participation in 2000 but, now, normalized by the calibrated distortion for the sector with highest import share in the final year. Since the calibrated distortion in the final year is considerably smaller then in the initial year (0.1361 and 0.3, respectively), the impact on the aggregate outcomes of keeping a profile of sectoral distortions implied by the data in 2000 in the long run would be less strong than in the previous counterfactual that uses the initial calibrated distortion as the normalization, presented in column 7. Still, the aggregate output and consumption both decrease by roughly 26% which is higher than the benchmark final BGP decline. The aggregate capital, in turn, remains fairly stable with a mild decrease which is not enough to maintain the output-capital ratio to its initial level, thus declining by just 1 p.p. relative to the initial BGP. In contrast, the output price slightly increases relative to the final benchmark. The interest rate remain roughly the same whereas the aggregate import share and capital share increase by approximately 1.8 p.p. and 13.9 p.p. relative to the benchmark initial BGP. It is worth noting that the aggregate TFP declines by 26% while the price composite decreases by a mild 0.5%.

Lastly, column 8 presents the last counterfactual that allows the sectoral productivity to change as well to its calibrated level in 2011. As discussed in the previous subsection, the calibrated sectoral productivities declined for most of the sectors. Thus, the resulting decline in the aggregate outcomes mimics the decline shown in column 6. In particular, the normalized aggregate output and consumption drop by as much as 47% while the aggregate capital decline by 32%. These declines are considerably higher than the actual benchmark calibration for the final BGP. Also, the output-capital ratio decreases to 26.9%, a lower decrease than the benchmark final BGP, while the output price and economy wide interest rate increases by 47.15% and 6.35 p.p. relative to the benchmark initial BGP. Additionally, the aggregate import share and capital share increases by 1.5 p.p. and 35.3 p.p. relative to the benchmark initial BGP.

One important difference between the counterfactual results in columns 6 and 8 is that only the price composite changes. The reason is that the aggregate TFP is invariant to homogeneous change in the distortions. In the last column all the distortions were scaled down given the smaller calibrated distortion in the final BGP used to normalize the relative distortions. Therefore, all the differences between columns 6 and 8 come from the dynamic effect resulting from a relatively smaller decline in the price composite of about 19% (compared to 34% in column 6).

5.3 Disaggregated effects of sectoral distortions

This section explores the disaggregated effects of changes in sectoral distortions on aggregate output, total factor productivity and the price composite of sectoral distortions and productivities. Table 5 presents the balance growth path relative values for these variables when only the distortion of each sector is decreased by 10 percent one at time, holding constant all the productivity parameters in their 1995's level. For comparison, the second row shows the relative values of the outcome variables when all the sectoral distortions change to their final BGP level.

The results of the exercise show that the aggregate output increases around 32.7% when all the distortions are set to their final level. However, the static effect measured by the TFP, $\mathcal{A}$, accounts for only a small part of the total increase in the aggregate output. Most of the effect happens through the dynamic incentives for capital accumulation.

Table 5 also provides in Panel A and Panel B, respectively, the 5 sectors with the greatest impact on aggregate output and the bottom 5 sectors with the least impact. Interestingly, the "Education" sector presents the strongest impact on BGP aggregate output and both the static and dynamic effects appear to contribute to the increase with the static effect being responsible for most of the change. In all the top five impact the static effect tend to contribute relatively more for the overall increase in aggregate output.

In Panel B the weakest impact as given by the "Food, Beverages and Tobacco" with a negative effect on aggregate output of about 5% of which the static effect contributes to the decline of more than 7% whereas the dynamic effect partially dampened the negative effect. For the bottom five sectors with the least impact, the static effect drives the mild negative effect on aggregate output (between $2\% - 4.8\%$) while the dynamic effect mitigates it. This results shed lights on the possibility of opposing static versus dynamic effects generated by policies that reduces distortions. Moreover, it makes explicit the political economy potential issues arising from policies aimed at alleviating distortions and the trade-off between static versus dynamic gains.

The overall results indicate an important decline in productivities for most of the sectors accompanied by a decline in the sectoral distortions that preserved the positive and sizeable correlation between productivities and distortions in the Mexican economy. However, it seems to be that the Mexican economy diverted from a path of worsening its profile of sectoral distortions that took place until 2000 and redirected to a path of lessening the severity of the economic distortions. The results also suggest that for a class of distortions that can be summarized as a wedge over the sectoral output prices

Table 5: STATIC AND DYNAMIC RESPONSES TO A 10 PERCENT DECREASE IN SECTORAL DISTORTIONS

Sector by sector change - Productivity constant in 1995			
Sectors	Total Output	$\mathcal{A}$	$\mathcal{B}$
Baseline sectoral distortions in 1995	1	1	1
Final sectoral distortions in 2011	1.32	1.02	1.34
Panel A: Top five greatest output impact			
Education	3.22	2.00	1.72
Real Estate Activities	2.68	1.75	1.62
Water Transport	2.61	1.81	1.52
Other Supporting and Auxiliary Transport Activities; Activities of Travel Agencies	2.03	1.54	1.37
Coke, Refined Petroleum and Nuclear Fuel	1.94	1.48	1.36
Panel B: Bottom five least output impact			
Basic Metals and Fabricated Metal	0.98	0.96	1.01
Electrical and Optical Equipment	0.97	0.97	1.00
Construction	0.96	0.94	1.02
Transport Equipment	0.96	0.95	1.01
Food, Beverages and Tobacco	0.95	0.92	1.03

Notes: The table shows the responses of total output, the aggregate TFP, $\mathcal{A}$, and the price composite of productivities, $\mathcal{B}$, to a 10 percent decrease in sector by sector distortions. All the responses are measured relative to the baseline levels of the endogenous variables in 1995, keeping the sectoral productivities constant at their initial level. Panel A shows the aggregate impact of the five sectors with the strongest effects while Panel A shows the bottom five sectors with the weakest impact.

in the economy, the change in their profile may have differential static versus dynamic impacts on the aggregate output and growth mechanisms. Accounting for both impacts when designing growth policies would increase the likelihood of enacting output growth that truly reflects the improvements of the economy fundamentals.

6 Conclusion

This paper addresses the question of how static distortions affect the growth incentives in terms of capital accumulation and technology adoption. The main motivating fact is the sluggish growth experience faced by the Mexican economy since the debt crisis during de 1980's in spite of major macroeconomic reforms put in place. The lack of growth directed the policy debate from macro towards micro reforms that could tackle many distortions in the Mexican economy. Thus, an important question that arises is how these distortions relate to the growth mechanisms.

We propose a model where distortions are linked to growth mechanisms, namely, capital accumulation and exogenous technology adoption resulting from international trade, through the general equilibrium rate of return on capital. Changes in the sectoral distortions have two potentially opposing effects: a short run impact on the aggregate TFP – the static effect – and a long run effect on the rate of capital accumulation that exceeds the rate of technology adoption – the dynamic effect. In contrast to the basic neoclassical model in which both effects are tight together, in the model presented in this paper a change in the distortions may decrease the aggregate output whereas stimulate growth through its effect on the actual rate of return (the ratio between the rate of return and the output price).

The results suggest that the Mexican economy experienced this differential effect where aggregate TFP decreased while the actual rate of return increased leading to capital deepening despite of an overall drop in the aggregate output in the balanced growth path. Moreover, if the distortions remained at their initial level aggregate output would have increased in the balanced growth path. Also, the results suggest that if the distortions continued at their maximum dispersion as of in 2000 the aggregate output would drop as much as 56%. Overall, the Mexican economy seemed to be in a path of worsening sectoral distortions that apparently reverted since 2000. It is important to highlight that, although an interesting case, the Mexican trajectory is far from exception. Therefore, the analysis carried in this paper would easily apply to other countries, specially in Latin America.

Altogether, the results raise a cautioning warn over policies that aim at triggering growth. They suggest that reforms in sectoral distortions might backfire in terms of its effect on aggregate productivity in spite of promoting growth. It may generate the false impression of a successful intervention when it, in fact, decreases productivity that intended to promote. Although this paper does not address any specific reform, it could be viewed as a step towards improving our understanding on how microeconomic reforms could lead to economic growth.

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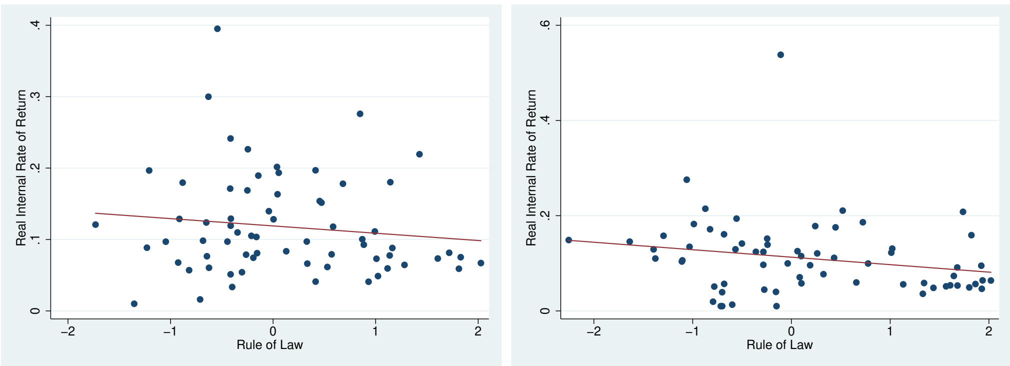
Appendices

A Additional Cross Country Evidence

Figure 8 depicts relationship between the real internal rate of return (from the PWT9.1) and Worldwide Governance Indicator of "Rule of Law" calculated by the World Bank, as a rough measure of the level of distortions. In contrast to the relationship shown in the text, when the groups of countries are divided by the growth rate of GDP per capita, instead of the growth rate of GDP per worker, both groups display a negative relationship. It worth emphasizing that the model predicts this negative correlation in the BGP. To the extent that countries with above median growth might be enjoying the transition growth rates, the presence of the correlation for the high growth group would be somewhat unexpected.

Figure 8: Appendix: Cross Country Real Internal Rate of Return and Misallocation in 2017 (by real GDP per capita growth rate)



(a) Above median growth (b) Bellow median growth

B Derivation of the Equilibrium and Aggregation

B.1 Derivation of equation 13

The first order conditions(FOC) for the cost minimization problem of the differentiated products firms given the technology, equations 5 and 6, implies the following firm-level exports (equal to the foreign firm-level demand for country's n varieties):

$$\begin{aligned}\int_{\nu\in n} p(\nu)x(\nu)d\nu &= \int_{\nu\in n} \left(p(\nu)X_{s,n'}\right)^{1-\epsilon}\left((1-\alpha)c_s(r_n,\tilde{P})y_{s,n'}\right)^{\epsilon} d\nu \\ &= \left((1-\alpha)c_s(r_n,\tilde{P})y_{s,n'}\right)^{\epsilon} X_{s,n'}^{1-\epsilon}\int_{\nu\in n} p(\nu)^{1-\epsilon}d\nu \\ &= \left(\tilde{P}X_{s,n'}\right)^{\epsilon} X_{s,n'}^{1-\epsilon} n p_n^{1-\epsilon} \\ &= n\left(\frac{p_n}{\tilde{P}}\right)^{1-\epsilon}\tilde{P}X_{s,n'}\end{aligned} \tag{22}$$

The first equality is obtained by substituting the FOC. The second reflect that only prices are indexed by varieties. The third substitutes the FOC again and uses the fact the $p(\nu) = p_n,\ \forall \nu \in n$. Summing over sectors and across countries we obtain the right hand side of equation 13.

B.2 Derivation of equation 14

The total labor demand in country n comprises the total demand for the intermediate tradable varieties of the country. Thus,

$$\begin{aligned}\int_{\nu\in n} \ell(\nu)d\nu &= \int_{\nu\in n} x(\nu)d\nu \\ &= \int_{\nu\in n}\left(\frac{p(\nu)}{\tilde{P}}\right)^{-\epsilon} X_{s,n'}d\nu \\ &= n\left(\frac{p_n}{\tilde{P}}\right)^{-\epsilon} X_{s,n'}\end{aligned} \tag{23}$$

Summing over sectors and across countries we obtain the right hand side of equation 14.

B.3 Proof of Proposition 1

Before we get to the proof of Proposition 1 it is helpful to begin by deriving the country n import participation in total trade, X_n^R (the R superscript stands for ratio).

From labor market clearing equation 14 we have:

$$\begin{aligned}\left(\frac{p_n}{\tilde{P}}\right)^{\epsilon} &= \frac{n}{\tilde{P}} \underbrace{\int \tilde{P}\bar{X}_{n'} dG(n')}_{\equiv X^W} \\ \Rightarrow \frac{p_n}{\tilde{P}} &= \left(\frac{nX^W}{\tilde{P}}\right)^{\frac{1}{\epsilon}}\end{aligned} \tag{24}$$

Now, substituting the above equation into the ideal price index equation 9, we obtain:

$$\begin{aligned}\tilde{P} &= \left(\int_0^N p(\nu)^{1-\epsilon} d\nu\right)^{\frac{1}{1-\epsilon}} \\ &= \left(\int np_n^{1-\epsilon} dG(n)\right)^{\frac{1}{1-\epsilon}} \\ &= \left(\int n\left(\tilde{P}^{\frac{\epsilon-1}{\epsilon}}\left(nX^W\right)^{\frac{1}{\epsilon}}\right)^{1-\epsilon} dG(n)\right)^{\frac{1}{1-\epsilon}} \\ \Rightarrow X^W &= \left(\int n^{\frac{1}{\epsilon}} dG(n)\right)^{\frac{\epsilon}{\epsilon-1}}\end{aligned} \tag{25}$$

Substituting the above equation and equation 24 into the trade balance equation 13, we obtain the country's n import participation in the world trade:

$$\begin{aligned}X_n^R \equiv \frac{\tilde{P}\bar{X}_n}{X^W} &= n\left(\frac{p_n}{\tilde{P}}\right)^{1-\epsilon} \\ &= n\left(\frac{nX^W}{\tilde{P}}\right)^{\frac{1-\epsilon}{\epsilon}} \\ &= \frac{n^{\frac{1}{\epsilon}}}{\int n^{\frac{1}{\epsilon}} dG(n)}\end{aligned} \tag{26}$$

Now we are ready to prove Proposition 1. In BGP, by definition, consumption growth rate is the same across all countries. Let us define this common consumption growth rate as g_c. From the definition of the import participation we have that total imports are given by:

$$\bar{X}_n = X_n^R \frac{X^W}{\tilde{P}} = n^{\frac{1}{\epsilon}} \left(\int n^{\frac{1}{\epsilon}} dG(n)\right)^{\frac{1}{\epsilon-1}} \tag{27}$$

Since the mass of intermediate tradable varieties grows at the same rate of the total mass of varieties available in the world economy we can define θ such that $n = \theta_n N$.

Therefore, total imports are given by

$$
\begin{aligned}
\bar{X}_n &= N^{\frac{1}{\epsilon}} \theta_n^{\frac{1}{\epsilon}} N^{\frac{1}{\epsilon(\epsilon-1)}} \left(\int \theta_n^{\frac{1}{\epsilon}} dG(n) \right)^{\frac{1}{\epsilon-1}} \\
&= N^{\frac{1}{\epsilon-1}} \theta_n^{\frac{1}{\epsilon}} \left(\int \theta_n^{\frac{1}{\epsilon}} dG(n) \right)^{\frac{1}{\epsilon-1}} \\
&= N^{\frac{1}{\epsilon-1}} f(\theta_n) \\
\Rightarrow \frac{\dot{\bar{X}}}{\bar{X}} &= \frac{1}{\epsilon-1}\lambda
\end{aligned}
\tag{28}
$$

Now it suffices to show that the aggregate output and capital grow at the same rate as the total imports. The euler equation (eq. 15) and the actual rate of return in equation 16 then imply that the rate of return is constant and given by

$$
r^* = \left(\frac{\sigma}{\sigma-1} \frac{g_c + \delta + \rho}{\mathcal{B}} \right)^{\frac{1}{1-\alpha}} \tag{29}
$$

The technical marginal rate of substitution then implies:

$$
\begin{aligned}
\frac{\bar{K}}{\bar{X}} &= \frac{\alpha}{1-\alpha} \frac{1}{r^*} \\
\Rightarrow \frac{\dot{\bar{K}}}{\bar{K}} &= \frac{\dot{\bar{X}}}{\bar{X}}
\end{aligned}
\tag{30}
$$

The aggregate output in each country, equation 17, implies that $\dot{Y}/Y = \dot{\bar{K}}/\bar{K}$. Finally, the consumer budget constraint, equation 2, implies that $g_c = \lambda/(\epsilon-1)$.

B.4 Derivation of equation 17

The first order conditions (FOC) for the cost minimization imply

$$
\begin{aligned}
K_{s,n} &= \alpha \left(\frac{\tilde{P}}{r_n} \right)^{1-\alpha} \frac{y_{s,n}}{z_{s,n}} \\
\Rightarrow \bar{K}_n &= \alpha \left(\frac{\tilde{P}}{r_n} \right)^{1-\alpha} \frac{Y_n}{\mathcal{A}_n}
\end{aligned}
\tag{31}
$$

The second equality follows substituting the optimal output in each sector, equation 12, and summing over sectors. Rearranging the expression we obtain equation 17.

C Additional Calibrated Parameters and Model Fit

C.1 Sectoral Productivity Parameters

Table 6: Appendix: Sectoral productivity parameters calibrated values for the Mexican economy

Internally Calibrated (Part 1)			
		Year	
Sector (total=34)	Parameter	1995	2011
Agriculture, Hunting, Forestry and Fishing	z_1	0.16623	0.10132
Mining and Quarrying	z_2	0.27127	0.1648
Food, Beverages and Tobacco	z_3	0.080331	0.058322
Textiles and Textile Products	z_4	0.11368	0.11079
Leather, Leather and Footwear	z_5	0.27287	0.26014
Wood and Products of Wood and Cork	z_6	0.40774	0.44204
Pulp, Paper, Printing and Publishing	z_7	0.10891	0.11828
Coke, Refined Petroleum and Nuclear Fuel	z_8	0.54165	0.41707
Chemicals and Chemical Products	z_9	0.11094	0.097056
Rubber and Plastics	z_{10}	0.096973	0.078286
Other Non-Metallic Mineral	z_{11}	0.24781	0.22089
Basic Metals and Fabricated Metal	z_{12}	0.063788	0.048154
Machinery, Nec	z_{13}	0.095845	0.074789
Electrical and Optical Equipment	z_{14}	0.02079	0.016148
Transport Equipment	z_{15}	0.032381	0.027461
Manufacturing, Nec; Recycling	z_{16}	0.083701	0.071669
Electricity, Gas and Water Supply	z_{17}	0.21988	0.07959

Notes: The table shows the internally calibrated sectoral productivity parameters for sectors 1-17. The sectoral participation in total GDP for the respective sector is targeted and discipline productivity parameters in the calibration for the Mexican economy. The sectoral participation in total GDP for the Mexican economy is calculated from the WIOT Release 2013.

Table 7: APPENDIX: SECTORAL PRODUCTIVITY PARAMETERS CALIBRATED VALUES FOR THE MEXICAN ECONOMY

Internally Calibrated (Part 2 Final)			
		Year	
Sector (total=34)	Parameter	1995	2011
Construction	z_{18}	0.073632	0.055492
Sale, Maintenance and Repair of Motor Vehicles and Motorcycles; Retail Sale of Fuel	z_{19}	0.17134	0.15189
Wholesale Trade and Commission Trade, Except of Motor Vehicles and Motorcycles	z_{20}	0.15638	0.14159
Retail Trade, Except of Motor Vehicles and Motorcycles; Repair of Household Goods	z_{21}	0.17732	0.16379
Hotels and Restaurants	z_{22}	0.394	0.39603
Inland Transport	z_{23}	0.19162	0.10112
Water Transport	z_{24}	0.74868	0.9
Air Transport	z_{25}	0.34917	0.20046
Other Supporting and Auxiliary Transport Activities; Activities of Travel Agencies	z_{26}	0.58334	0.51215
Post and Telecommunications	z_{27}	0.29098	0.19875
Financial Intermediation	z_{28}	0.31998	0.32641
Real Estate Activities	z_{29}	0.71745	0.76403
Renting of M& Eq and Other Business Activities	z_{30}	0.15789	0.15789
Public Admin and Defence; Compulsory Social Security	z_{31}	0.3844	0.28042
Education	z_{32}	0.84686	0.9
Health and Social Work	z_{33}	0.21542	0.1584
Other Community, Social and Personal Services	z_{34}	0.38211	0.30641

Notes: The table shows the internally calibrated sectoral productivity parameters for sectors 18-34. The sectoral participation in total GDP for the respective sector is targeted and discipline productivity parameters in the calibration for the Mexican economy. The sectoral participation in total GDP for the Mexican economy is calculated from the WIOT Release 2013.

C.2 Sectoral Participation in Total GDP

Table 8: Appendix: Model fit of the sectoral participation in total GDP for the Mexican economy

(Part 1)		1995		2011	
Sector (total=34)	Parameter	Model	Data	Model	Data
Agriculture, Hunting, Forestry and Fishing	z_1	0.046715	0.047173	0.034271	0.034141
Mining and Quarrying	z_2	0.051049	0.051938	0.071156	0.07049
Food, Beverages and Tobacco	z_3	0.081647	0.081004	0.075221	0.074829
Textiles and Textile Products	z_4	0.018098	0.018035	0.0090722	0.0089903
Leather, Leather and Footwear	z_5	0.006208	0.006223	0.0030467	0.0029771
Wood and Products of Wood and Cork	z_6	0.0044705	0.0044594	0.0024464	0.0024019
Pulp, Paper, Printing and Publishing	z_7	0.018472	0.018351	0.010515	0.01061
Coke, Refined Petroleum and Nuclear Fuel	z_8	0.021208	0.021311	0.021365	0.021369
Chemicals and Chemical Products	z_9	0.041557	0.041998	0.028304	0.028283
Rubber and Plastics	z_{10}	0.011088	0.01105	0.0084939	0.0084497
Other Non-Metallic Mineral	z_{11}	0.013197	0.013304	0.010253	0.010168
Basic Metals and Fabricated Metal	z_{12}	0.03674	0.036284	0.038556	0.038018
Machinery, Nec	z_{13}	0.0068575	0.0067566	0.0080716	0.0079862
Electrical and Optical Equipment	z_{14}	0.04759	0.043629	0.043463	0.044728
Transport Equipment	z_{15}	0.055422	0.05213	0.056494	0.055775
Manufacturing, Nec; Recycling	z_{16}	0.010583	0.010497	0.0098283	0.0097023
Electricity, Gas and Water Supply	z_{17}	0.012942	0.012835	0.020786	0.020675

Notes: The table shows the model fit of the sectoral participation in total GDP for sectors 1-17 both in 1995 and 2011. The sectoral participation in total GDP for the Mexican economy is calculated from the WIOT Release 2013. The model fit for the remaining targets, that is, the output-capital ratio and real internal rate of return is shown in the main text.

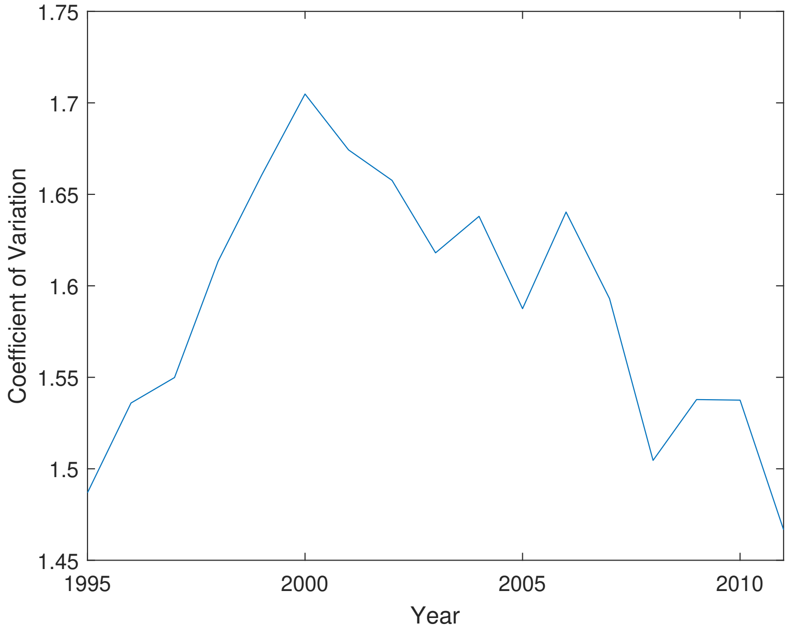
Table 9: APPENDIX: MODEL FIT OF THE SECTORAL PARTICIPATION IN TOTAL GDP FOR THE MEXICAN ECONOMY

(Part 2 Final)		1995		2011	
Sector (total=34)	Parameter	Model	Data	Model	Data
Construction	z_{18}	0.057498	0.05728	0.078683	0.078593
Sale, Maintenance and Repair of Motor Vehicles and Motorcycles; Retail Sale of Fuel	z_{19}	0.0090786	0.0090702	0.009289	0.0091793
Wholesale Trade and Commission Trade, Except of Motor Vehicles and Motorcycles	z_{20}	0.058928	0.058985	0.064501	0.064544
Retail Trade, Except of Motor Vehicles and Motorcycles; Repair of Household Goods	z_{21}	0.051187	0.051892	0.057464	0.056783
Hotels and Restaurants	z_{22}	0.023282	0.023653	0.017135	0.017149
Inland Transport	z_{23}	0.049696	0.050235	0.050726	0.050931
Water Transport	z_{24}	0.00092865	0.00091939	0.00047376	0.00062074
Air Transport	z_{25}	0.003323	0.0033269	0.0042362	0.0042005
Other Supporting and Auxiliary Transport Activities; Activities of Travel Agencies	z_{26}	0.0055951	0.0056009	0.00616	0.0061872
Post and Telecommunications	z_{27}	0.017842	0.017945	0.026604	0.026088
Financial Intermediation	z_{28}	0.048022	0.048965	0.038094	0.037618
Real Estate Activities	z_{29}	0.068245	0.071156	0.05261	0.052771
Renting of M&Eq and Other Business Activities	z_{30}	0.036207	0.036611	0.045708	0.045746
Public Admin and Defence; Compulsory Social Security	z_{31}	0.026097	0.026526	0.033917	0.033675
Education	z_{32}	0.026479	0.026945	0.027258	0.030989
Health and Social Work	z_{33}	0.020156	0.020253	0.0224	0.022171
Other Community, Social and Personal Services	z_{34}	0.013593	0.013659	0.013398	0.013161

Notes: The table shows the model fit of the sectoral participation in total GDP for sectors 18-34 both in 1995 and 2011. The sectoral participation in total GDP for the Mexican economy is calculated from the WIOT Release 2013. The model fit for the remaining targets, that is, the output-capital ratio and real internal rate of return is shown in the main text.

C.3 Import Participation in Sectoral GDP

Figure 9: Appendix: Sectoral Import Participation for Mexico in 1995-2011 - Coefficient of Variation



C.4 Counterfactual responses to sectoral decrease in the distortions

Table 10: Appendix: Static and dynamic responses to a 10 percent decrease in sectoral distortions

Sector by sector change - Productivity constant in 1995			
(Part 1)			
Sectors	Total Output	$\mathcal{A}$	$\mathcal{B}$
Baseline sectoral distortions in 1995	1	1	1
Final sectoral distortions in 2011	1.3273	1.0235	1.3483
Education	3.2218	2.0044	1.7258
Real Estate Activities	2.6835	1.7566	1.6277
Water Transport	2.6166	1.8144	1.5234
Other Supporting and Auxiliary Transport Activities; Activities of Travel Agencies	2.0352	1.5462	1.3716
Coke, Refined Petroleum and Nuclear Fuel	1.9469	1.4836	1.3668
Hotels and Restaurants	1.5207	1.2724	1.2274
Wood and Products of Wood and Cork	1.5165	1.2917	1.2026
Public Admin and Defence; Compulsory Social Security	1.499	1.2586	1.2225
Other Community, Social and Personal Services	1.4799	1.2607	1.2024
Air Transport	1.3792	1.2193	1.1522
Financial Intermediation	1.3526	1.1648	1.1875
Post and Telecommunications	1.2892	1.1534	1.1365
Mining and Quarrying	1.2498	1.1073	1.1494
Leather, Leather and Footwear	1.2443	1.1396	1.1064
Other Non-Metallic Mineral	1.2104	1.1132	1.101
Electricity, Gas and Water Supply	1.1669	1.0884	1.0834

Notes: The table shows the responses of total output, the aggregate TFP, $\mathcal{A}$, and the price composite of productivities, $\mathcal{B}$, to a 10 percent decrease in sector by sector distortions. All the responses are measured relative to the baseline levels of the endogenous variables in 1995, keeping the sectoral productivities constant at their initial level. Sector are presented in descending magnitude of impact on "Total Output".

Table 11: Appendix: Static and dynamic responses to a 10 percent decrease in sectoral distortions

Sector by sector change - Productivity constant in 1995			
(Part 2 Final)			
Sectors	Total Output	$\mathcal{A}$	$\mathcal{B}$
Health and Social Work	1.1608	1.079	1.0876
Inland Transport	1.1115	1.0312	1.0901
Sale, Maintenance and Repair of Motor Vehicles and Motorcycles; Retail Sale of Fuel	1.1018	1.0537	1.0528
Retail Trade, Except of Motor Vehicles and Motorcycles; Repair of Household Goods	1.0893	1.0178	1.0813
Agriculture, Hunting, Forestry and Fishing	1.0769	1.0134	1.0725
Renting of M& Eq and Other Business Activities	1.0734	1.0178	1.0631
Wholesale Trade and Commission Trade, Except of Motor Vehicles and Motorcycles	1.0544	0.99369	1.0706
Textiles and Textile Products	1.0381	1.0093	1.0329
Pulp, Paper, Printing and Publishing	1.0335	1.0064	1.0311
Machinery, Nec	1.031	1.0132	1.0202
Rubber and Plastics	1.0292	1.009	1.023
Manufacturing, Nec; Recycling	1.0199	1.0039	1.0183
Chemicals and Chemical Products	1.0154	0.98165	1.0396
Basic Metals and Fabricated Metal	0.98118	0.96654	1.0174
Electrical and Optical Equipment	0.97747	0.9757	1.0021
Construction	0.96821	0.94832	1.0242
Transport Equipment	0.96018	0.95505	1.0062
Food, Beverages and Tobacco	0.95223	0.92806	1.03

Notes: The table shows the responses of total output, the aggregate TFP, $\mathcal{A}$, and the price composite of productivities, $\mathcal{B}$, to a 10 percent decrease in sector by sector distortions. All the responses are measured relative to the baseline levels of the endogenous variables in 1995, keeping the sectoral productivities constant at their initial level. Sector are presented in descending magnitude of impact on "Total Output".