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Abstract: This paper documents that Mexican households anticipated the fiscal reform of 2014 several months before enacted. This change in expectations is documented using a novel source of information available in Google Trends, among other sources. It then analyzes the economic consequences of this change using a general equilibrium growth model with taxes and uncertainty. The model also considers the presence of generic distortions in the form of wedges in the first order conditions to isolate the effect of taxation. The paper provides an explanation for the unusual trajectories of investment and GDP of the Mexican economy around 2013.
Keywords: business cycles, expectations, taxes, investment
JEL Classification: E30, E22, E62

Resumen: Este artículo documenta que los hogares mexicanos anticiparon la reforma fiscal de 2014 varios meses antes de que fuera implementada. Se documenta este cambio en expectativas utilizando información novedosa disponible en Google Trends, entre otras fuentes. Luego, analiza las consecuencias económicas de este cambio usando un modelo de crecimiento en equilibrio general con impuestos e incertidumbre. Para aislar el efecto de los impuestos, el modelo también considera la presencia de distorsiones genéricas que toman la forma de cuñas en las condiciones de primer orden de los agentes. El artículo provee una explicación para las trayectorias inusuales de la inversión y el PIB de la economía mexicana alrededor de 2013.
Palabras Clave: ciclos económicos, expectativas, impuestos, inversión

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1 Introduction

The identification of the sources of business cycles has remained an elusive task for Macroeconomists. Many aspects of the economy move in consonance which makes it hard to disentangle the original sources of fluctuations. In this paper, we explore the quantitative importance of one source of fluctuations: "the fear of taxes." Since economic agents are forward looking, changes in expected taxation can alter current optimal decisions and economic outcomes. The goal of this paper is to document and analyze a recent episode of changes in expectations about higher taxes. We combine three main tools of analysis to circumvent the identification problem referred above. First, we use a model that links tax rates to economic choices; second, we use several external sources to document the concern of agents about a possible tax hike in the near future; and third, we acknowledge the existence of other distortions, different than taxes, in order to isolate the effect of taxation.

The paper focuses on a recent episode of tax reform in Mexico, and the main argument is as follows. Mexican households anticipated -a year in advance- the fiscal reform that was enacted in 2014. This was due to the timing of the parliamentarian process, the communication strategy of the government, and other factors. Households perceived the possibility of a tax hike which affected the expected real rate of return of investments. As a result, agents responded by optimally reducing investment in 2013. We refer to this mechanism as the "fear of taxes." Once the reform was in place in 2014, and thanks to the promise of no more tax increases for the following years, the expected real rate remained stable, and investment started to pick-up.

A key part of the paper is to document the concern of agents regarding future taxes. This is performed in section 2.2. Using a number of different data sources, including Google Trends and measures of confidence of firm owners and other agents, we document the way in which expectations were influenced during 2013. We also describe the timing of the parliamentary process to make the point that such timing allowed firms to anticipate the introduction of new taxes.

We use a standard general equilibrium growth model to address the quantitative importance of this mechanism on main aggregates. There is a representative firm that faces taxes on capital and dividends, and a representative household that faces taxes on consumption and labor, as well as other distortions in the form of wedges to the first order conditions as in Chari et al. (2007) (CKM, henceforth). We calibrate this model by matching relevant moments of the Mexican economy. Using data on tax collection and national accounts, we estimate effective taxes using the methodology of Mendoza et al. (1994) and Conesa et al. (2007), but modified to reflect the particularities of the Mexican tax code. Given our estimated tax rates, we compute wedges associated with non-tax distortions in the Mexican economy by forcing the equalization of the first order conditions to the data. Using this methodology we can decompose CKM wedges into a tax wedge –a wedge related to the evolution of tax rates– and a non-tax wedge, and assess which component has been more relevant for the recent performance of the Mexican economy. Once the model is calibrated, we perform several counter-factual exercises. Altogether, these exercises allow us to conclude that variation in tax rates across time is an important driver of Mexico's performance, although non-tax wedges have also played a similarly important role. This decomposition constitutes the first important contribution of the paper.

Next, we assess the quantitative importance of the "fear of taxes" mechanism in 2013 using counter-factual exercises, which provides the key contribution of the paper. In particular, we show that the way agents react in the model to the expectation of higher taxes is fairly consistent with what we observe in the data. Moreover, we show that the model is able to capture the decrease in investment observed in 2013 and its subsequent recovery in 2014. The model is also able to capture the drop in the growth rate of GDP in 2013.

Several facts of the data are consistent with the "fear of taxes" mechanism. We observe both, a contraction of aggregate investment and a substantial increase in the amount of dividends paid by large companies in 2013 –before the reform was enacted. Then, we observe a weak recovery of investment remaining below trend in 2014, and a drop of dividends returning to its usual trend. One additional observation is that 2013 distinguishes as a year where investments in US and Mexico were disconnected: while US investment was soaring, Mexico's investment was shrinking. This contrasts with virtually all other years in more than a decade, where a positive relationship between US and Mexico's investment was in place. This supports the hypothesis that the collapse in investment was rooted in domestic factors.

In our model, there is a trade-off between paying dividends and investing: the more dividends are paid, the less resources are available to invest. We argue that the anticipation of the introduction of a dividend tax prompted firms to pay dividends sooner than previously planned, and that such anticipation induced them to reduce investments. In the model, the main mechanism by which taxes affect investment is through the impact on its rate of return. For example, if dividend taxes are expected to be higher next period this reduces the return of current investment because each dollar invested today will have a lower purchasing power tomorrow.

Note that, it is only when dividend taxes are expected to differ between two consecutive periods that the rate of return of investment is affected. In contrast, when dividend taxes are constant over time these have no effect on the rate of return, or on any other equilibrium condition. The reason for this is that the cost of investment and its return are affected proportionally by the dividend tax, which keeps unaltered the Euler equation. Furthermore, since taxes are given back in a lump-sum fashion, there are no additional income effects that affect equilibrium. In this sense, dividend taxes are the less disruptive among all four taxes analyzed. Note also that consumption taxes affect the Euler equation in a very similar way than dividend taxes do. However, a key difference is that consumption taxes have also a permanent effect on hours worked by modifying the return to hours worked.

When dividend and consumption taxes differ across time they can have a significant, but temporary effect on investment. As a result, the change in these taxes can explain the sharp decline in investments in 2013, but can not explain why investment had a rather weak recovery and stayed below trend after that period. Taxes on capital, in contrast, have a permanent effect on the equilibrium rate of return which can alter the evolution of investment in future periods. We argue that the combination of changes in all these taxes explains the recent evolution of investment in Mexico.

Related literature The role of taxes as a source of business cycles has been previously emphasized by the literature. Hayashi and Prescott (2002) use a growth model with capital taxes to study the case of Japan. In Bergoeing et al. (2002), the authors study the role of fiscal policy to explain fluctuations in Chile and Mexico. In Conesa et al. (2007) the authors examine the case of Finland, and in Papageorgiou (2012) the author analyzes the case of Greece.

Meza (2008) studies the case of a fiscal reform in Mexico during the 1995 crisis using a growth model with taxes. He finds that the change in fiscal policy accounts for roughly

20% of the fall in aggregate output.

Perhaps, McGrattan (2012) is the closest paper to ours. She studies the role of fiscal policy during the Great Depression of the United States. She finds that the anticipation of higher taxes during this period can explain a substantial part of the patterns of output, investment, and hours worked during that period. She also finds that the most important tax policy was the one related to dividend taxes, which showed an important increase during the period.

Our paper distinguishes from the rest in the following way. First, we emphasize the role of expectations about future fiscal policy. Except for the work in McGrattan (2012), no other paper of the above has emphasized the role of expectations as in our paper. We distinguish from McGrattan's work in that we use a much more recent episode of changes in tax policy and we use data from an emerging economy. We believe that the case for anticipation is stronger in our paper as we have access to better data (such as Google trends). Second, we decompose CKM wedges into a component that depends on taxes (tax wedge) and one that depends on everything else (non-tax wedge). The contribution consists on providing this decomposition for the case of Mexico, an important developing country, and to assess the relative importance of each component.

The paper is organized as follows. In section 2 we present an empirical motivation of the fear of taxes mechanism, in section 3 we present the model, in section 4, the calibration strategy, and in section 5, the results. Finally, sections 6 and 7 offer a discussion of the main results and conclude, respectively.

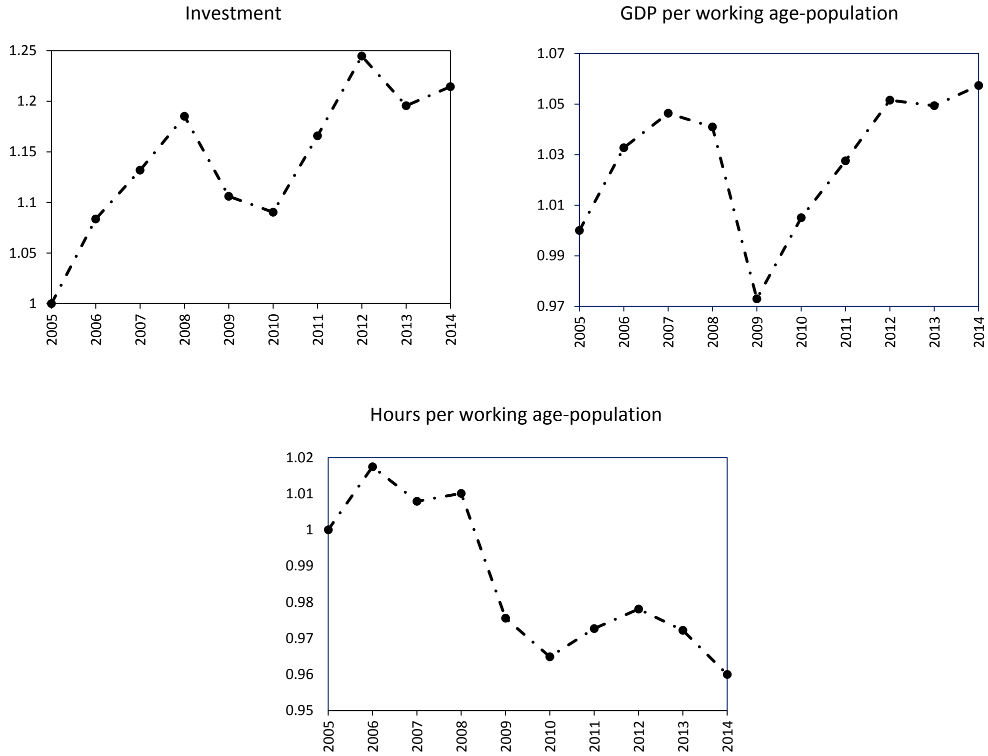
2 Motivation

The following section presents relevant information about the Mexican economy, the legislative process, and the concern that agents experienced in advance of the reform.

2.1 Recent evolution of the Mexican economy

Figure 1 presents the recent evolution of three main aggregates of the Mexican economy: real investment, GDP per working-age population, and hours worked per working-age

Figure 1: Recent evolution of the Mexican economy

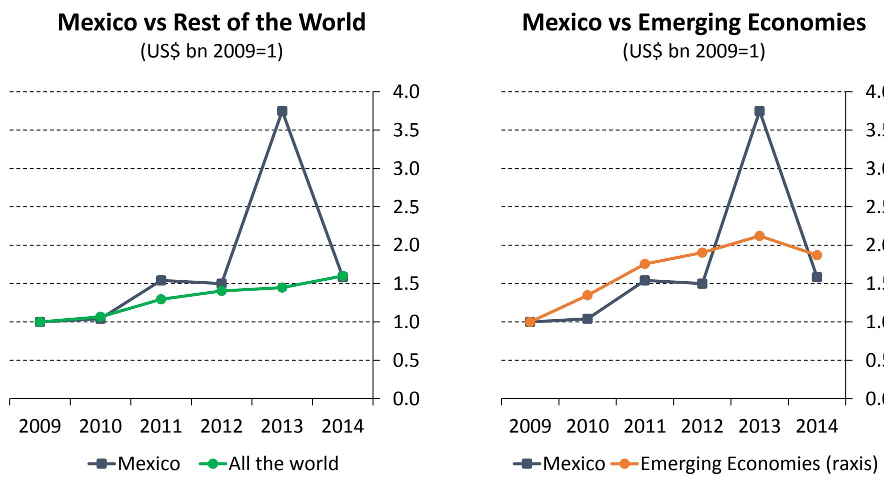


population. Investment, which is presented in the graph located at the top-left of the figure, shows a steady increase during the period of 2005 to 2008. Then, it presents a sharp decline during the global financial crisis, followed by a subsequent recovery during 2011 and 2012. Finally, note that, in 2013, investment experiences a significant reduction that is only partially reverted in the following year.

Note, similarly, that GDP per working-age population in the Figure (top-right panel) shows a reduction in its growth rate represented by a flatter line during 2013 and 2014. Finally, note that hours per working-age population also present a reduction during 2013 and 2014. The focus of this paper is precisely the evolution of the main aggregates during these two years (2013-2014).

Figure 2 presents the Henderson Global Dividend Index for three sets of countries: Mexico, emerging economies, and the world. This index tracks dividends paid by the largest corporations in several countries and it is expressed in real US dollars. Dividends in Mexico, according to this index, had a boom during 2013, and then returned to its usual trend during 2014. Figure 3 presents an alternative time series of dividends in

Figure 2: Dividends paid by the largest corporations in Mexico (Currency: USD)

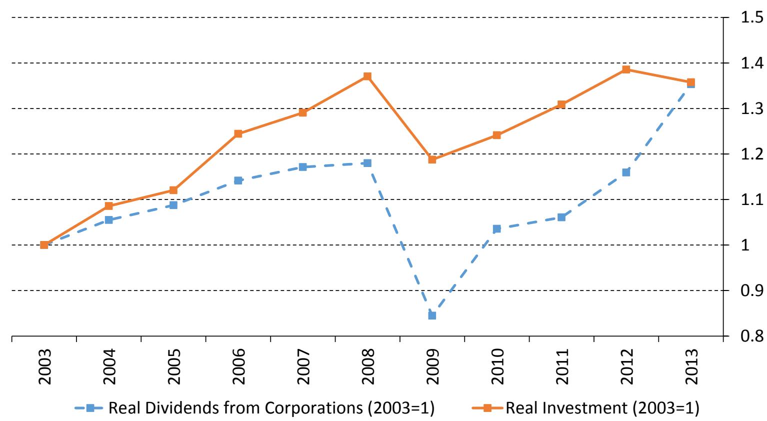


Mexico obtained from national accounts and expressed in real pesos. The Figure compares the evolution of dividends with the one of real investments made by corporations. We see that over the 2003-2013 decade, the two variables kept a positive relationship: both, investment and dividends, increased or decreased simultaneously. However, right in 2013 dividends substantially increased, while investment decreased. This is the only year where this phenomenon occurred in over a decade. One of the main arguments in the paper is that the substantial increase in dividends observed in 2013 occurred as a response to the expectation of higher dividend taxes in the future, and that this was done at the expense of investment expenditures.

One possible reason behind the abnormal change in investment during 2013 is that it was due to external forces present in that year. To explore this possibility, Figure 4 shows a scatter plot of investment in the US vs. investment in Mexico. The relationship between these two variables is usually positive, that is, when US investment is growing, Mexico's investment is also growing, and vice versa. However, we see that 2013 is a year characterized by a negative relationship between these two measures: while the US investment was growing, Mexico's investment was falling. This supports the idea that the decline in Mexico was due to internal factors. We argue that one strong candidate among these internal factors are the expected changes in taxation.

Compare the 2013 episode with what happened to investment in these two countries

Figure 3: Mexico's dividends and investments



during the recent global financial crisis (2009). Note that in this case, investment levels in both countries are falling. Thus, we can argue that the fall in Mexico's investment in 2009 is related to external factors. Compare it now with the 1995 financial crisis. In this case, Mexico's investment was falling but the US one was growing. So, the 2013 and the 1995 episodes are similar in that they seem to have originated by internal factors.

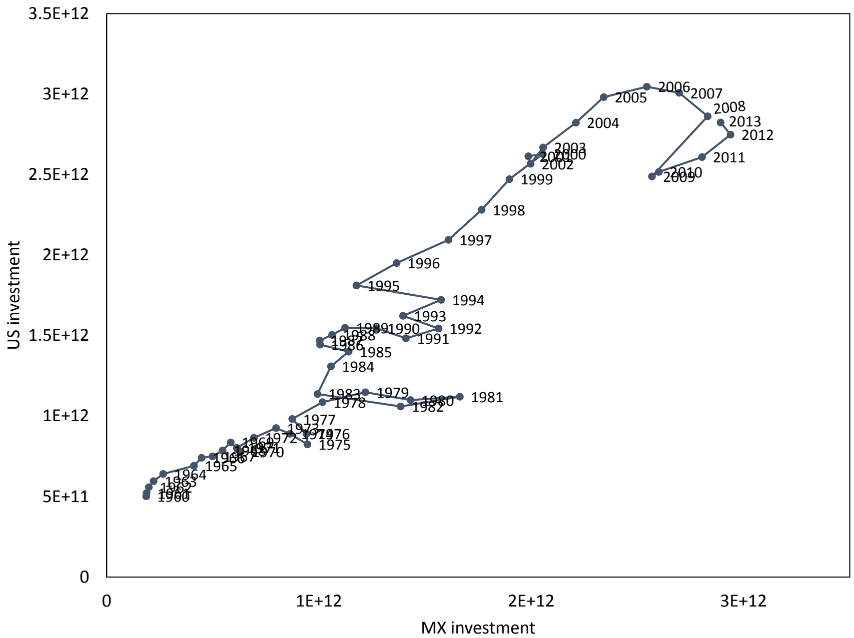
2.2 How agents expectations where influenced during 2013

This section documents that Mexican society had information in advance of the 2014 fiscal reform, and that agents were able to anticipate a permanent increase in tax rates.

By the end of 2012, Mexican government authorities announced that, during the forthcoming months, they would send to the congress a proposal for tax reform.[1] The plan was to get the reform approved during 2013, and to start 2014 with a new set of taxes. At the time, two main features of the still unknown proposal were extensively discussed in the press: 1) changes in the VAT, and 2) the elimination of "fiscal privileges" for large corporations. The main changes in VAT discussed where the expansion of the set of goods subject to taxation to include food and medicines, as well as an increase in

[1]Discussions in the press about the need for a fiscal reform where in place since the second half of 2012. See, for example http://www.eluniversal.com.mx/finanzas/98746.html. But it was not until the end of 2012 when government officials publicly announced their plans for fiscal reform in 2013.

Figure 4: US and Mexico's Investment



the VAT tax rate; while the main changes in the corporate tax referred to the rules for consolidated tax returns of large corporations.

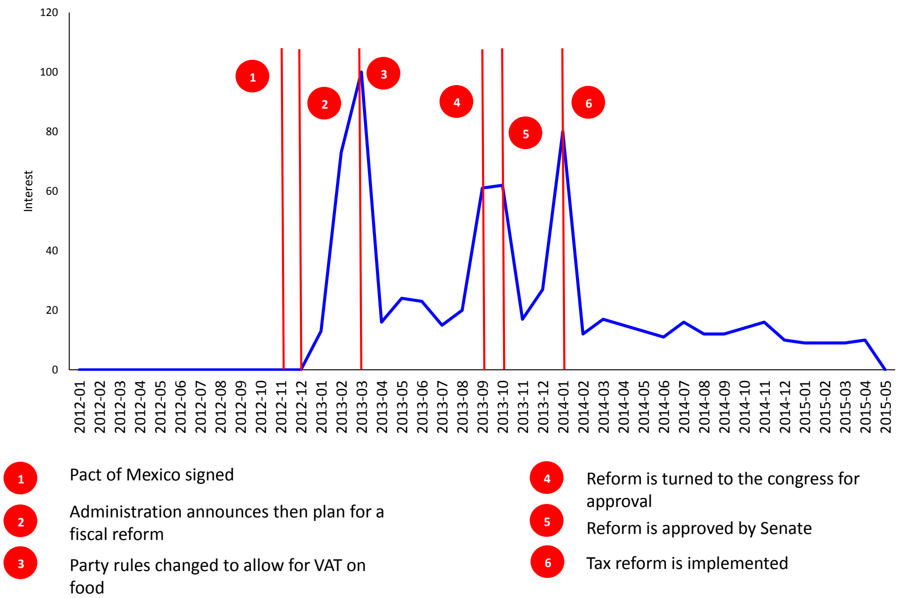
We argue that several events occurring along the year 2013 increased expectations that tax changes were likely to occur in the following year. First, the party with the majority in congress and an ally of the federal government (the PRI), started a process to change its internal rules to be able to vote in favor of increasing VAT on food.[2] Second, "The pact for Mexico" was announced at the end of 2012. It consisted of an agreement that included the participation of a number of key political actors to push forward several reforms in congress. This agreement included an explicit reference to the fiscal reform and to the "fiscal privileges" enjoyed by corporations.[3] Finally, the reform was turned to the congress for approval in September 2013 (four months before it was implemented). At that point, the details of the reform were made available to the public.

One piece of information obtained from Google Trends gives support to the idea that agents anticipated the fiscal reform. Figure 5 shows a time series of the intensity of

[2]"PRI plantea cambiar IVA en alimentos y medicinas" http://www.eluniversal.com.mx/notas/900737.html

[3]"Reforma fiscal a fondo, meta de pacto" http://www.cnnexpansion.com/economia/2012/12/02/reforma-fiscal-a-fondo-meta-de-pacto

Figure 5: Interest on web searches for "VAT on food" and timing of events.



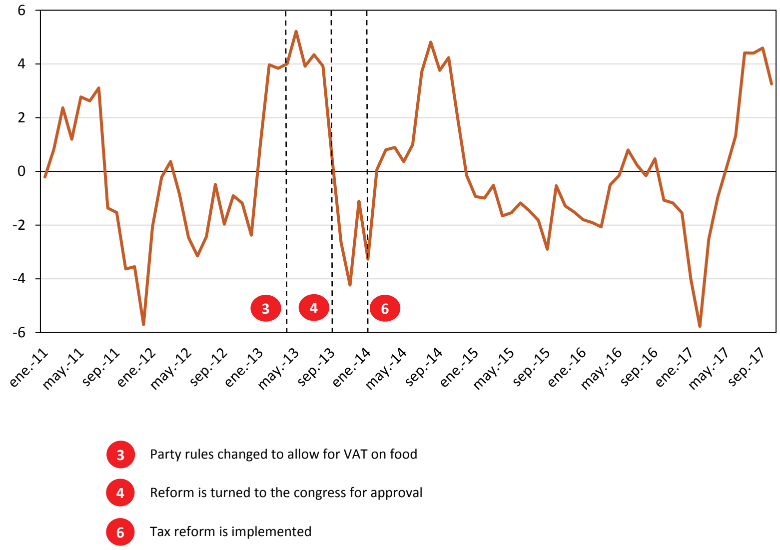
Source: Google Trends and press releases.

searches in Google for the concept of "VAT on food."[4] The Figure provides evidence that the concern about potential changes on the VAT was present in the Mexican society one year before the tax reform was actually implemented. The Figure also shows that the peaks in search intensity coincide with the dates of the events that provided strong signals about future taxation. For example, label 3 in the figure coincides with the date in which the PRI party changed its internal rules, and point 4 with the date in which the reform was turned to the congress.

One additional piece of information that also supports this idea is the measurement of manager's confidence that is regularly undertaken by Banco de México. The "Firm Owner's Confidence Index" is constructed from the answers provided by firm owners or managers to a questionnaire about the current economic situation. Figure 6 presents a time series of the answer to the question of whether today is the right time to invest or not.[5] We observe in the Figure that during the second half of 2013 the confidence about the right time to invest of firm owners was reduced. Moreover, we also observe that this confidence started to recover only after the reform was implemented. It is important to note that the confidence index presented in the Figure is obtained through direct interviews to owners or managers of firms, and thus, it represents a different source of

[4]The source is Google Trends, and the exact search terms are "IVA en alimentos," within Mexico.
[5]We take the cyclical component of the index using an hpfilter smoother.

Figure 6: "Right time to invest" index



Source: Banxico.

information than the one in Figure 5 which is obtained from Google Trends.

One aspect of the reform that was revealed in September of 2013 consisted on the introduction of a new tax on dividends. Given the timing of the legislative process, firms were aware of the possibility of this new tax four months ahead of its implementation. As a result, firms conducted investors assemblies to vote on dividend payments during the last few months of 2013. The goal of these meetings was to pay dividends in advance of the reform, and to be able to legally avoid the new tax.[6]

3 Model

We use a standard general equilibrium growth model, which has been extensively used to study the macroeconomic effect of taxes (e.g. Hayashi and Prescott (2002); Bergoeing et al. (2002); Conesa et al. (2007); Chari et al. (2007); Meza (2008) and more

[6]http://eleconomista.com.mx/mercados-estadisticas/2013/12/22/firmas-pagan-30706-millones-dividendos
http://www.jornada.unam.mx/2013/12/11/economia/032n1eco
http://www.forbes.com.mx/femsa-propondra-pago-adelantado-de-dividendo/
http://www.elfinanciero.com.mx/archivo/accionistas-salvan-mil-495-mdp-con-adelanto-de-dividendos.html

recently Chari et al. (2016)). In this model, taxes and other wedges distort the decisions undertaken by firms and households. The main goal is to study the equilibrium of this economy when agents are faced with changes in expectations about future taxes.

Representative firm There exists a representative firm that has access to the production function:

$$y_t = A_t F(k_t, h_t), \tag{1}$$

where k_t is capital, h_t are hours of labor, and A_t is total factor productivity. In the calibration section, we will assume that the production function is of the Cobb-Douglas type: $A_t F(k_t, h_t) = A_t k_t^{\alpha} h_t^{1-\alpha}$. The firm is the owner of the capital, which can be accumulated using the following rule:

$$k_{t+1} = x_t + (1-\delta) k_t, \tag{2}$$

where x_t is investment in period t, and the endowment of capital at the beginning of life is k_0 units.

The per-period dividends of this firm are given by:

$$d_t(h_t, k_{t+1}, k_t) = A_t F(k_t, h_t) - w_t h_t - x_t ...$$

$$-\tau_t^k \left(A_t F(k_t, h_t) - w_t h_t - \delta k_t\right).$$

where τ_t^k is the corporate income tax rate. Thus, dividends are obtained by subtracting labor costs, investments, and tax payments, out of output sales. Note that capital depreciation is deducted from the tax base for the case of the corporate income tax.

Given k_0, the problem of the representative firm is to choose sequences of capital and labor to maximize the discounted stream of after-tax dividends subject to the capital accumulation rule (2):

$$\max \left\{ \sum_{t=0}^{\infty} \frac{1}{\prod_{s=0}^{t}(1+R_s)} \left(1-\tau_t^d\right) d_t(h_t, k_{t+1}, k_t) \right\}$$

where τ_t^d is the tax on dividends. Note that the objective of the firm is on the stream of after-tax dividends, as opposed to the stream of before-tax dividends. Also note that the corresponding tax base for the tax on dividends is precisely d_t.

The first order conditions of this firm consist on an intra-temporal condition that determines how much labor to hire, along with an inter-temporal Euler equation that determines how much investment to make:

$$A_t F_h(k_t, h_t) = w_t \tag{3}$$

$$(1 + R_{t+1}) \left(1 - \tau_t^d\right) = \left(1 - \tau_{t+1}^d\right) \left(1 + \left(1 - \tau_{t+1}^k\right) (A_{t+1} F_k(k_{t+1}, h_{t+1}) - \delta)\right) \tag{4}$$

The intra-temporal condition 3 equates the marginal productivity of labor to the wage rate. The firm will hire more labor as long as the marginal productivity is above the marginal cost of the next unit hired. The inter-temporal condition 4, equates the marginal cost of investment to the rate of return on investment. These are expressed in terms of how investment affects the stream of after-tax dividends. Investing amounts to a reallocation of resources between dividends today vs. dividends tomorrow. The left hand side of this equation is the cost of giving up \$1 of today's dividends (expressed in tomorrow's units): giving up \$1 dollar of dividends in period t translates into a sacrifice of only $(1 - \tau_t^d)(\$1)$ after-tax dividends. The firm takes that dollar and makes investments which pay a return in the next period. This return increases next period's after-tax dividends in the amount given by the right hand side of equation 4. Let us remark that by giving up \$1 dollar of today's dividends, the firm is able to avoid the payment of today's dividend taxes (τ_t^d), which is why this tax rate appears in the left hand side of the equation. Similarly, by investing and using the resulting returns to pay for dividends in the next period, the firm faces corporate and dividend taxes in that period (τ_{t+1}^k and τ_{t+1}^d), which is why these tax rates appear in the right hand side.

Note also that when dividend taxes are constant over time, both sides of the Euler equation are affected by the same factor and any two consecutive tax rates (e.g. τ_t^d and τ_{t+1}^d) cancel out. This is intuitive: the Euler equation makes the firm indifferent between paying \$1 more dollar of today's dividends or paying dividends tomorrow after making investments. Thus, if the tax rates on dividends are the same today and tomorrow, the decision of when to pay them should not be affected.[7]

The observation above implies that dividend taxes affect investment levels as long as tax rates change over time. In such scenario, the cost and the return of investment would be affected not-proportionally.

Finally, notice the contrasting effects of corporate taxes, τ^k, on investment. In the case of these taxes, there is a permanent effect on the rate of return and on the level of investment. This occurs even if the tax rate remains constant over time.

Representative household There is an infinitely lived household that values leisure and consumption, with preferences given by:

$$\sum_{t=0}^{\infty} \chi_t \beta^t u(c_t, 1 - h_t),$$

where c_t is consumption in period t, h_t represents hours worked in period t, β is the discount factor, and u is a utility function with standard properties on continuity and concavity. χ_t is a time varying shifter which is included with the purpose of creating a wedge in the inter-temporal first order condition (see below). We assume that this evolves according to $\chi_{t+1} = \psi_t \chi_t$, where ψ_t is a parameter and χ_0 is given. Thus, the entire series of χ_t is taken as given by the household. The effects on equilibrium allocations of changes in this parameter are similar to the effects from changes in the discount rate (if this was allowed to vary). When this parameter increases, it is as if the discount rate would have increased. This means that the future is more valuable; and, thus, investment must go up. Note also that an increase in this parameter can also be interpreted as an increase in the rate of return of investment.

The household has access to a one period maturity bond. Thus, each period the income of the household can be used either to save or to consume. The household is endowed

[7] The reader should keep in mind that in the analysis performed in this paper, it is assumed that the tax revenue stemming from each of the taxes is rebated to the consumer through a lump-sum transfer. The equilibrium effect of taxes on consumption, investment, and output, certainly, depends on this assumption. If the government throws the tax revenue to the sea instead, this would introduce an additional distortion that diverts resources out of consumption and investment. This “feasibility” effect might be of quantitative importance if tax revenue varies over time. However, in this paper, as in many others regarding the effect of taxes in the Macroeconomy, we have decided to abstract from such margin in order to focus on the first order effect of taxation on aggregate variables.

with 1 unit of time every period, which can be used either as time working, or as leisure. The problem consists on choosing how much to consume, save, and work in each period to maximize preferences subject to a budget constraint.

The household receives income flows every period from two main sources: labor income and dividends. Labor income is subject to taxation, according to the rate τ_t^l, and dividends are obtained by the household once the corresponding taxes are withheld by firms. In addition, consumption is also subject to taxation at the rate τ_t^c. Thus, the budget constraint in period t is given by:

$$(1+\tau_t^c)c_t + B_{t+1} - (1+R_t)B_t = (1-\tau_t^l)\theta_t w_t h_t + (1-\tau_t^d)d_t + Rev_t,$$

where w_t is the wage rate, and B_t is the outstanding debt at the beginning of period t. θ_t is a time varying parameter that is included in order to create a non-tax wedge in the intra-temporal first order condition (see below). Note that θ_t is isomorphic to a labor tax. Rev_t is a lump-sum transfer that keeps the government budget balanced.

Thus, the problem of the household is to maximize preferences subject to the budget constraint, given prices, taxes and non-tax wedges. The first order conditions of the household are given by:

$$\frac{u_{l,t}}{u_{c,t}} = \left(\frac{1-\tau_t^l}{1+\tau_t^c}\right)\theta_t w_t \tag{5}$$

$$\frac{u_{c,t}}{\beta u_{c,t+1}} = \psi_t \left(\frac{1+\tau_t^c}{1+\tau_{t+1}^c}\right)(1+R_{t+1}) \tag{6}$$

Note that non-tax wedges θ_t and ψ_t affect the first order conditions as in CKM. The purpose of these time-varying parameters is to capture all kind of distortions –different than taxes– that affect the Mexican economy. As is standard in the literature about wedges, their value is chosen so that the model replicates the data for a set of relevant macroeconomic time series (see section 4).

Equilibrium conditions The optimal conditions above can be combined with the corresponding ones from the firm's problem to arrive at the following equilibrium conditions:

$$\frac{u_{l,t}}{u_{c,t}} = \left(\frac{1-\tau_t^l}{1+\tau_t^c}\right)\theta_t(1-\alpha)Ak_t^\alpha h_t^{-\alpha} \tag{7}$$

$$\frac{u_{c,t}}{\beta u_{c,t+1}} = \psi_t\left(\frac{1+\tau_t^c}{1+\tau_{t+1}^c}\right)\left(\frac{1-\tau_{t+1}^d}{1-\tau_t^d}\right)\left(1+\left(1-\tau_{t+1}^k\right)\left(\alpha Ak_{t+1}^{\alpha-1}h_{t+1}^{1-\alpha}-\delta\right)\right) \tag{8}$$

The first expression is the intra-temporal first order condition, which equates the marginal rate of substitution between consumption and leisure to the marginal return of hours worked (7). Note that this return is the marginal productivity of labor adjusted by labor and consumption taxes and by the intra-temporal non-tax wedge. Labor taxes affect this expression by reducing the return of hours worked. As a result, the higher the labor tax, the less hours the individual will be willing to supply to the market.[8] The presence of consumption taxes affects the return of hours worked in a similar way. The reason for this is that consumption taxes –as labor taxes– reduce the actual purchasing power of the return to hours worked. Finally, the intra-temporal non-tax wedge, θ_t, affects the return to hours worked by scaling up and down the right hand side of equation 7.

The second expression is an Euler equation, an inter-temporal first order condition which equates the marginal rate of substitution between consumption today and consumption tomorrow to the marginal return in the market of 1 unit of consumption today (8). The right hand side summarizes the available opportunities in this economy to transform units of today's consumption into units of tomorrow's consumption. In this economy, this transformation is done through saving and investing. Thus, the return is affected by the taxes faced by both, the household, and the firm, as well as by the inter-temporal non-tax wedge. Consumption taxes affect the return of saving, while dividend and corporate taxes, affect the return of investing. In turn, the inter-temporal non-tax wedge, ψ_t, scales this return up and down over time.

Notice that consumption and dividend taxes affect the rate of return only when their tax rates vary over time. When constant, these tax rates cancel out from the Euler equation.

[8] The fact that the revenue from taxation is given back to the household through a lump-sum transfer plays a crucial role in this result. For a very clear an illustrative explanation see Rogerson (2010).

We explained this feature for the case of dividend taxes in the previous section. The intuition is similar for the case of consumption taxes. Today's consumption taxes are part of the cost of saving and tomorrow's taxes are part of the return from saving. When the tax rate is constant, both, the cost and the return are affected proportionally, and thus, the marginal choice is unaffected. Nevertheless, an important difference of consumption taxes with respect to dividend taxes is that the former also enter in the intra-temporal FOC (equation 7) as we explained above. As a result, consumption taxes affect the optimal choice of labor, even in the case where the tax rates are constant over time. This effect on the labor choice indirectly affects the equilibrium interest rate R_t, and the level of investment as well.

Finally, keep in mind the way in which the non-tax wedges affect equilibrium conditions. On the one hand, the parameter θ_t is isomorphic to a labor tax, thus, affecting the amount of hours worked. On the other hand, the parameter ψ_t scales up and down the return of investment. The higher is the parameter ψ_t, the higher the rate of return, and the higher the investment level in equilibrium.

These parameters (θ_t and ψ_t), along with taxes, constitute the total intra-temporal and inter-temporal wedges, as defined in CKM. The total intra-temporal wedge, for example, corresponds to the difference (in the data) between, the marginal rate of substitution between consumption and leisure on one side; and the marginal product of labor on the other side. In the model, this wedge is jointly determined by τ_t^l, τ_t^c, and θ_t, and is given by the factor $\Gamma_t^{tot} = \left(\frac{1-\tau_t^l}{1+\tau_t^c}\right)\theta_t$. Analogously, the total inter-temporal wedge corresponds to the difference between, the marginal rate of substitution between consumption today and tomorrow on the one side, and the real rate of return to saving and investing on the other side. This wedge is jointly affected by the change in consumption and dividend taxes between t, and $t+1$,$\left(\frac{1+\tau_t^c}{1+\tau_{t+1}^c}\right)\left(\frac{1-\tau_{t+1}^d}{1-\tau_t^d}\right)$, the tax on capital in $t+1$,τ_{t+1}^k, and by ψ_t . In the next section we provide a decomposition of the total intra-temporal and inter-temporal wedges into their corresponding tax and non-tax components. Thus, with our model, we will be able to identify the importance of taxes in the evolution of CKM wedges.

Table 1: Labor income share in Mexico

Methodology	Labor income share
Naive	0.28
Conesa et al. (2007)	0.34
PWT, 8.1	0.38

4 Calibration

The goal in this section is to calibrate the value of the parameters of the model. In particular, we need to determine the value of the technological and preference parameters as well as to construct time series for the capital stock, total factor productivity, and the effective tax rates for Mexico. Additionally, we also present, in this section, the methodology for the calculation of the two non-tax wedges considered in the paper.

The first parameter to calibrate is α, a parameter of the technology, which is related to the labor income share according to the first order conditions of the firm's problem. As Gollin (2002) argued, a naive calculation using the Compensation of Employees from National Accounts would underestimate the actual share. The reason for this is that labor income that goes to self-employed workers and to unpaid family workers, which represent a large fraction in developing countries, is not taken into account. One possible correction to the data is the one found in Conesa et al. (2007), which define the labor income share as "unambiguous labor income divided by GDP net of the ambiguous categories (household net mixed income and indirect taxes)." Another available correction to the data is the one found in the recent Penn World Tables 8.1, which adjust this share to circumvent Gollin's critique. Table 1 reports these two measures of the labor income share.

In any case, the labor income share in Mexico, after correcting for Gollin's critique, is low and around 0.35. According to this, we set $\alpha = 0.65$.

Next, we need to construct a time series for the capital stock that is consistent with the capital accumulation equation of the model. For this purpose it is necessary to obtain an assessment of the average capital-output ratio, and the value of δ in Mexico. The Mexican statistical agency, INEGI, recently released a capital stock series which averages around 2.54 of GDP during the period 1990 to 2013. In addition, using INEGI's data on gross fixed capital formation and the equation for capital accumulation above, we can retrieve the implied value of δ that is consistent with this capital series[9]. It turns out that the implied value of δ varies across time, averaging around 0.054 for the period in which INEGI has capital data. Using the INEGI's average capital-output ratio, and the implied average value of δ, along with data for gross fixed capital formation, we construct a capital series consistent with the capital accumulation equation of the model.

Given the capital stock, and using data for output and hours worked per working age population (wap), we can calculate total factor productivity using the production function 1. Figure 7 presents a decomposition of the sources of growth in GDP per working age population for the 1985-2014 period. The Figure includes the evolution of: TFP, Hours worked per wap, and the capital-output ratio. Note that real output per wap in 2014 is only 10% higher than in 1985, which reflects a very low growth pace in Mexico. It is also useful to divide the growth analysis in two periods: before and after the beginning of the XXI century. Growth for the last fifteen years of the twentieth century was mainly due to TFP and hours per wap. Since then, both TFP and hours have shown a decreasing trend, and almost all growth in the twenty first century has been due to increases in the capital to output ratio.

Next, we calibrate effective tax rates. We compute taxes on consumption, τ_t^c, on labor, τ_t^l, and on capital, τ_t^k, for every period in which data is available. We use the Methodology of Mendoza et al. (1994) and Conesa et al. (2007), with a small modification to reflect the Mexican tax code more accurately. The exact procedure is described in the appendix. In general, the procedure consists on identifying two elements in the data related to each tax: a) the National Accounts counterpart of the statutory tax base; and b) the tax revenue. The effective tax rate is the ratio between these two elements. Figure 8 presents the evolution of these taxes for the period 2002 to 2012. In general, we see that tax levels are quite low relative to the standard levels found in developed countries. This is related to the presence of informality and tax evasion in Mexico, where a large fraction of economic activity is not subject to taxation. We see that the consumption tax is relatively stable with a slight positive trend; the labor tax first decreases, and then increases; while the capital tax goes up for a large part of the period, and it stabilizes around 0.085 by the end of the period.

[9]Interestingly, the average of the implied values of consumption of fixed capital as a ratio of GDP ($\delta_t K_t / Y_t$) in the INEGI capital series is 0.14

Figure 7: Growth decomposition

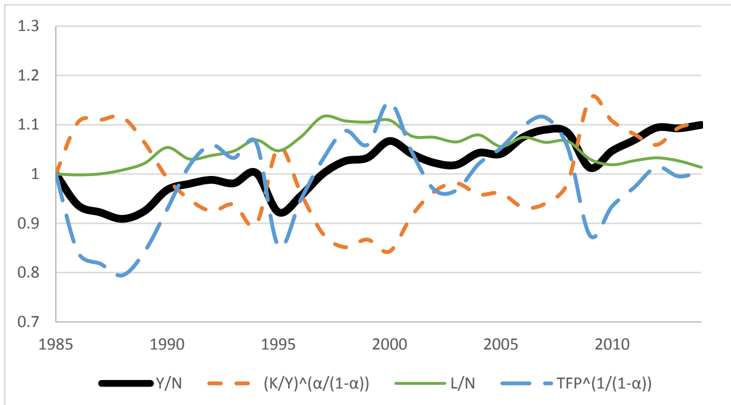


Figure 8: Taxes

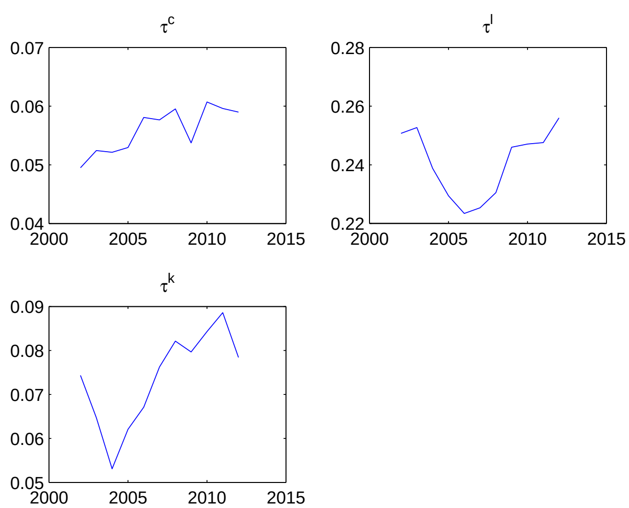


Table 2: Calibrated parameters

Parameter	Calibrated value
α	0.350
δ	0.054
β	0.875
γ	0.530

The explicit utility function that will be used is $u(c, 1-h) = \gamma ln(c) + (1-\gamma)ln(1-h)$. Given the time series of tax rates obtained, we calibrate the discount rate β, and the weight of consumption in the utility function γ. For this purpose, we assume that there are no distortions ($\theta_t = 1, \forall t$, and $\psi_t = 1,\forall t$) and use equations 7 and 8, to solve for the two parameters (β and γ) in each period of time. Then, we use data on consumption, output, capital and labor to obtain time series for both parameters. We are able to obtain values for these parameters for each year between 2002 and 2014, but we choose to take the average for the values between 2002 and 2012 to avoid including the years in which the policy change is analyzed (2013-2014). Using this methodology, we obtain $\beta = 0.8750$, and $\gamma = 0.5302$. Table 2 presents a summary of calibrated parameters.

Once all parameters and tax rates are calibrated, we compute the values of the intra- and inter-temporal non-tax wedges (θ_t and ψ_t) that are consistent with the data. Given that current decisions depend on the value of future wedges, we have to take a stand on what these values are. We assume that wedges remain constant from 2012 and until the end of the simulating period. We obtain the calibrated time series values of the non-tax wedges using an iterative procedure. First, we take an initial guess and solve the model numerically using this guess. Given the solution at this step, we compute investments, and hours worked in each period and compare these moments to the data. We update our initial guess and repeat this process with different values of the non-tax wedges looking for the values that minimize the distance between the model and the data. Figure 9 presents the value of the non-tax wedges for the period 2002 to 2012. We see first, that the value of the wedges is around 1, as one would expect in a situation where distortions are not dramatically large. Second, we see that the intra-temporal non-tax wedge has a decreasing trend from 2002 up to 2009, year after which the wedge starts to increase. Regarding the inter-temporal non-tax wedge, we see that after remaining fairly constant for half of the period, it increases in 2009 and remains high after that.

By construction, under this procedure, we are able to replicate the data perfectly.

Figure 9: Wedges

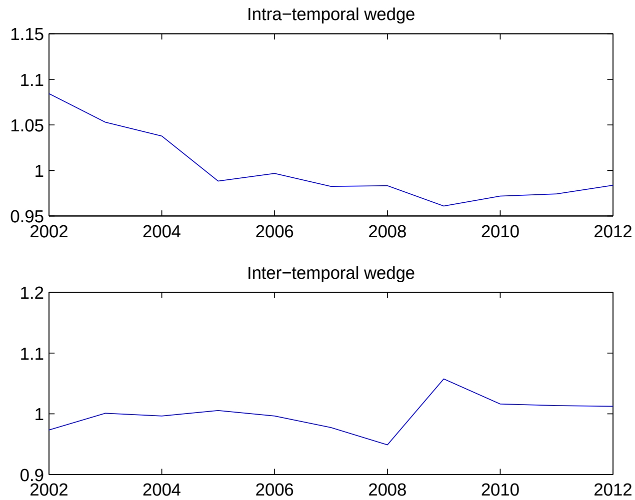


Figure 10 presents the model fit to the data.

4.1 Decomposing the total intra-temporal wedge and the total inter-temporal wedge

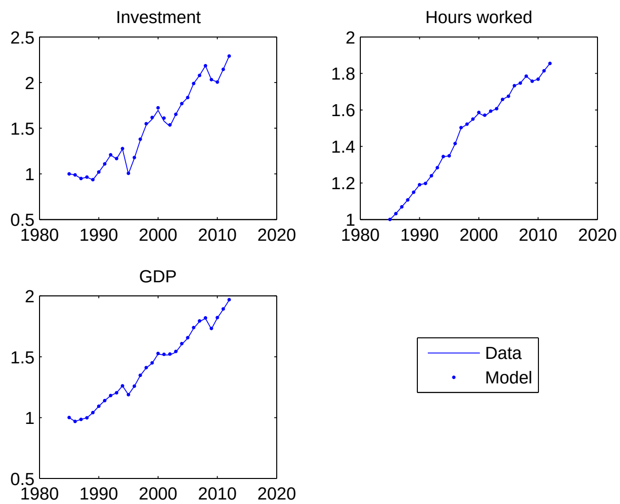
In this section, we perform a decomposition of wedges into two kinds of factors: those related to tax rates, and those related to other factors different than taxes. For this purpose, let us start by describing the decomposition exercise for the case of the intra-temporal wedge. Under the absence of distortions, the intra-temporal first order condition should equate the marginal rate of substitution between consumption and leisure ($MRS_t^{c,l}$) to the marginal productivity of labor (MPL_t), as follows:

$$MRS_t^{c,l} = MPL_t$$

$$\Rightarrow \frac{u_{l,t}}{u_{c,t}} = (1-\alpha)Ak_t^{\alpha}h_t^{-\alpha}$$

Under the presence of distortions, a total intra-temporal wedge Γ_t^{tot} emerges:

Figure 10: Model fit



$$MRS_t^{c,l} = \left(\Gamma_t^{tot}\right)\left(MPL_t\right),$$

The key observation is that Γ_t^{tot} can be decomposed into a tax wedge and a non-tax wedge. Let $\Gamma_t^{tot} = \Gamma_t^{tax}\Gamma_t^{nontax}$, where Γ^{tax} refers to the wedge associated with the presence of taxes (composed, in turn, of labor and consumption taxes), while Γ^{nontax} represents the wedge associated with other distortions, different than taxes.

In particular, note that, according to equation 5, the intra-temporal tax wedge is given by:

$$\Gamma_t^{tax} = \left(\frac{1-\tau_t^l}{1+\tau_t^c}\right)$$

while the non-tax intra-temporal wedge is:

$$\Gamma_t^{nontax} = \theta_t.$$

Figure 11 in panel (a), presents the time series for this decomposition. We observe that the level of the total intra-temporal wedge Γ^{tot} is around 0.7, which is a consequence of the fact that the tax wedge, Γ_t^{tax}, fluctuates around that level, while the non-tax wedge, Γ_t^{nontax}, fluctuates around 1. Nevertheless, the decreasing trend in Γ^{tot} is clearly driven by a similar trend in the non-tax wedge, which steadily decreases between 2002 and 2009, and remains fairly constant since then.

For the decomposition of the inter-temporal wedge, we proceed in the following way. We define the marginal rate of substitution between consumption today and consumption tomorrow as follows: $MRS_t^c = \frac{u_{c,t}}{\beta u_{c,t+1}}$. Similarly, the real rate of return on investment (RRI_t) under the absence of any kind of distortions (tax or non-tax) is given by: $RRI_t = 1+\alpha A_{t+1} k_{t+1}^{\alpha-1} h_{t+1}^{1-\alpha} - \delta$. Notice that the optimal condition when taxes are zero and there are no non-tax wedges is given by: $MRS_t^c = RRI_t$.

Next, consider the case when taxes are positive and non-tax wedges are present. Let us assume that the total inter-temporal wedge can be represented by the parameter Φ_t^{tot}. Furthermore, this total wedge can be decomposed into a tax related wedge and a non-tax related wedge: $\Phi_t^{tot} = \Phi_t^{tax}\Phi_t^{nontax}$. Thus, under the presence of taxes and distortions, the equilibrium condition can be written as:

$$MRS_t^c = \left(\Phi_t^{tot}\right)(RRI_t) = \left(\Phi_t^{tax}\right)\left(\Phi_t^{nontax}\right)(RRI_t).$$

Next, we set the value of the non-tax inter-temporal wedge, $\Phi_t^{nontax} = \psi_t$. By comparing the above equation to equation 8, we obtain that the inter-temporal tax wedge is given by the following expression:

$$\Phi_t^{tax} = \frac{MRS_t^c}{RRI_t}\frac{1}{\psi_t}$$

Note that this way of decomposing the total wedge has the advantage of being plain and simply. However it is important to note that, given the nature of the corporate tax (which affects only the return of investment and not the principal) the inter-temporal tax wedge depends on the evolution of TFP. To see this more clearly, note that Φ_t^{tax} will be equal to:

$$\Phi_t^{tax} = \frac{\left(\frac{1+\tau_t^c}{1+\tau_{t+1}^c}\right)\left(\frac{1-\tau_{t+1}^d}{1-\tau_t^d}\right)\left(1+\left(1-\tau_{t+1}^k\right)\left(\alpha A_t k_{t+1}^{\alpha-1} h_{t+1}^{1-\alpha} - \delta\right)\right)}{\left(1+\alpha A_t k_{t+1}^{\alpha-1} h_{t+1}^{1-\alpha} - \delta\right)}$$

Note that, by defining Φ_t^{tax} in this way, it is possible that even with constant tax rates, changes in TFP can induce movements in Φ_t^{tax}. Whether TFP is important for the evolution of Φ_t^{tax} is a quantitative question. In the appendix, we investigate the quantitative importance of TFP for the evolution of this tax wedge. We obtained that changes in TFP during this period were not an important driver behind the evolution of the inter-temporal tax wedge. In fact, the fraction of the variance in Φ_t^{tax} that is explained by TFP changes is negligible. This means that Φ_t^{tax} can indeed be interpreted as a tax wedge, because its main drivers are the fluctuations of capital and consumption taxes. For more details, please refer to the appendix.

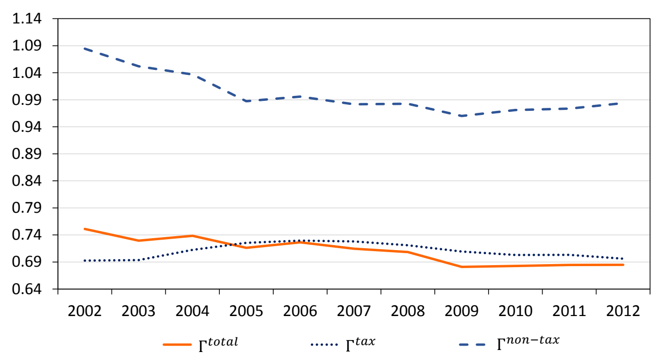
Figure 11 in panel (b) presents the decomposition of the total inter-temporal wedge. We observe that both components, tax and non-tax, have had an influence on the fluctuations of the total inter-temporal wedge. It is possible to identify two main periods in this evolution. First, between 2002 and 2006, the non-tax component remained fairly constant, and the changes in the total wedge were mainly driven by tax changes. In contrast, between 2007 and 2012, the tax component remained close to one, and the changes in the total inter-temporal wedge were mainly driven by the non-tax wedge. It is interesting to highlight the evolution of these wedges around the financial crisis. Prior to 2009, the actual real rate of return to investment was roughly 5 percentage points below the undistorted real rate of return to investment, as indicated by the total inter-temporal wedge around the level of 0.95. This period coincides with a period of favorable global financial conditions, mostly prevalent during the years 2007 and 2008. In contrast, during 2009 the total wedge jumps above one, and roughly adds 6 percentage points to the undistorted rate of return. This could be associated with the strong deterioration of financial conditions that occurred as a consequence of the financial crisis. Finally, note that the total wedge (as well as the non-tax wedge) went back to a lower level after 2009. This last movement is consistent with the improvement of financial conditions that occurred after a number of central banks around the globe undertook conventional and unconventional monetary policy actions to support economic activity.

5 Results

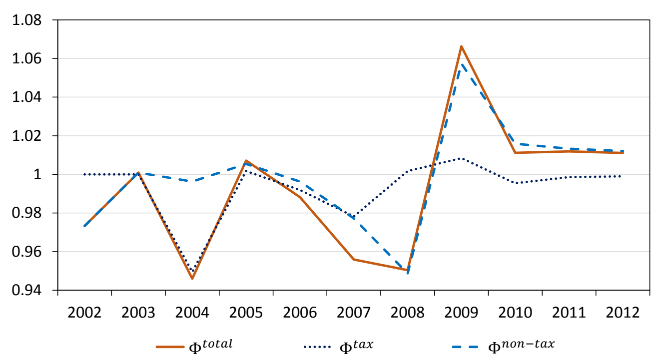
In this section, we use the calibrated model to perform a number of counter-factual exercises of interest. We divide these exercises in two sets. The first set analyzes the

Figure 11: Decomposition of total wedges

Panel (a): Intra-temporal wedge



Panel (b): Inter-temporal wedge



importance of taxes and wedges in the performance of the Mexican economy during the last decade. The second set, analyzes the quantitative importance of the “fear of taxes” mechanism by focusing on the fiscal reform of 2014.

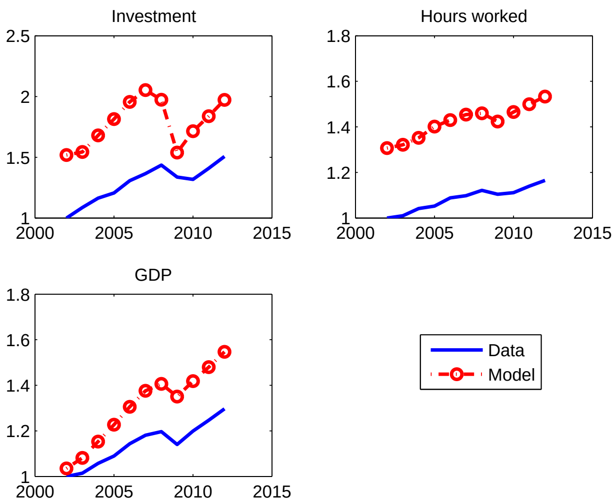
5.1 The role of taxes and wedges on economic fluctuations

In this section, we explore how important is the evolution of taxes and wedges for the evolution of investment, hours, and aggregate output. We perform this exploration using the model described above. The first interesting exercise is to look at how the economy would look like in the absence of taxes and wedges. To perform this, we start in 2002 with the same capital stock as in the baseline economy, but we set taxes to zero and wedges to one from that date on. Note that, in this model, an economy without distortions is equivalent to an economy that charges lump-sum taxes and gives back the revenue from these taxes as lump-sum transfers in such a way that the budget of the government is balanced at each period. The reason for this equivalence is that the resource constraint remains unaltered under such set of assumptions. Thus, comparing our baseline economy (with taxes and wedges) to an economy without taxes nor wedges is equivalent to compare the baseline economy to an economy with lump-sum taxes and transfers. The exercise can be thought as asking what is the role of distortionary taxation and wedges on the evolution of the Mexican economy, compared to a situation where taxation is made through the use of a non-distortionary tool (lump-sum taxes and transfers).

Figure 12 shows the result of this first exercise. By the end of 2012, the economy would have more than doubled its GDP level with respect to the baseline. More investment would have occurred and the capital stock would have surged; similarly, more hours would have been offered. In general, the picture shows the power of distortionary taxes to influence the equilibrium path in an important way. Figure 12 is also informative about the role of TFP. Since taxes are set to zero and wedges to one in this picture, the equilibrium path is only responding to changes in TFP. We can observe that, in this model, part of the recent financial crisis is captured by a decline in TFP.

Of course, we recognize the fact that lump-sum taxation is not a tool that is readily available for policymakers. Similarly, we recognize that, in the real world, tax revenue is used to provide valuable goods and services in addition to transfers. The result of the above exercise would certainly change if we had considered some "positive" role for the government, instead of simply giving back transfers. In particular, note that, in a richer model, the large loss in tax revenue implied by the reduction in taxes in the above counter-factual exercise could imply a cost in terms of lower provision of infrastructure and government expenditures. Nevertheless, the exercise is valuable as a way to identify the quantitative importance of the distortionary aspect of taxes and wedges.

Figure 12: Economy without taxes nor wedges



In the next exercise we modify the observed path of taxes in order to investigate what would have been the evolution of both, macroeconomic variables, and tax revenue. In this way, we are able to shed light on the distortionary aspect of taxes, as well as on the potential cost (or gain) associated with the provision of public goods when taxes change. The exercise is done using the decomposition of total wedges presented in the previous section, between tax and non-tax wedges. We proceed in the following way. We set the value of the intra-temporal tax wedge, Γ^{Tax}, to be equal to its 2002 value during the whole period (see top-left panel in Figure 13). We achieve this by modifying the value of the labor tax along the period. We proceed in a similar way for the case of the inter-temporal tax wedge, Φ^{tax}, in this case, by modifying the capital tax (see top right panel of Figure 13). The results are presented in Table 3. Columns 2 and 3 show the percentage change in the value of the variable between the hypothetical level under such policy and the actual level observed in the baseline calibrated economy.

In the second column, we observe that leaving the intra-temporal tax wedge, Γ^{Tax},

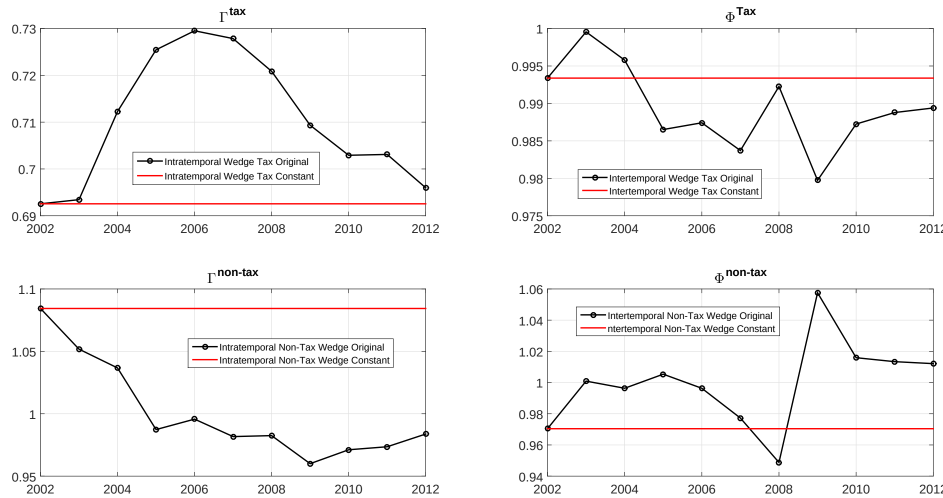
Table 3: Effect of leaving tax and non-tax wedges constant and equal to their 2002 value

	% change	
Variable	Γ^{Tax}	Φ^{tax}
Investment	-0.33	7.73
Hours Worked	-0.22	0.86
GDP	-0.97	3.78
Revenue τ^c	-0.42	4.23
Revenue τ^k	-0.42	-34.93
Revenue τ^l	.98	4.92
Revenue Tot	.26	-3.79

constant and equal to its value of 2002, would have required an important increase in the labor tax.[10] This increase would have affected hours worked, GDP and investment negatively. However, note that revenue from labor taxes, as well as total revenue, would have increased under such policy. In the third column, we observe that keeping the intertemporal tax wedge, Φ^{tax}, constant and equal to its value in 2002 would have required a reduction of capital taxes relative to their actual values over the period. This, in turn, would have implied a positive effect on investment, GDP and hours worked. However, notice that total tax revenue would have gone down by 3.8% as a result of this policy. In summary, this exercise allow us to more clearly appreciate the tradeoff between the distortionary aspect of taxes, and the potential benefit from higher revenue.

[10]To keep Γ^{Tax} constant there are two possibilities, either modify labor taxes or modify consumption taxes. We choose to modify labor taxes in order to avoid an unintended effect on the Euler equation through consumption taxes.

Figure 13: Taxes and wedges constant and equal to their values in 2002



5.2 The fear of taxes

Case of certainty. In this section, we assess the quantitative importance of the anticipation of the 2014 tax reform. The first exercise consists on assuming that agents start 2013 anticipating with certainty a fiscal reform that would permanently increase tax rates in Mexico, starting in 2014. In addition, we analyze the case of uncertainty in the next section. Given that our main interest is on the movement of aggregate variables during 2013, we assume that the tax rates prevalent in 2013 are the same as in 2012 in order to keep the exercise as clean as possible, but we relax this assumption later. Table 4 provides a time series of the tax rates assumed in this counter-factual exercise. To obtain the value of these taxes we used tax revenue data and the methodology described in the calibration. Note, in the Table, that the reform would increase all tax rates permanently, and would start exactly at 2014. Note also that the reform introduces a dividend tax (τ_d), which did not exist previously.

In Figure 14, we present the effect of the reform on the trajectory of real investment. Each panel in the Figure corresponds to a different hypothetical reform where each of the four taxes is increased separately, while leaving the rest of the taxes unchanged. In each of these panels, we can find the corresponding evolution of real investment: 1) when agents anticipate higher taxes (red dashed line), 2) when all taxes remain

Table 4: Effective tax rates for Counter-factual Exercise 1.

	τ_c	τ_l	τ_k	τ_d
2012	6.84%	25.60%	7.78%	0.00%
2013	6.84%	25.60%	7.78%	0.00%
2014	7.50%	29.12%	9.06%	2.33%
2015	7.50%	29.12%	9.06%	2.33%
$\vdots$	$\vdots$	$\vdots$	$\vdots$	$\vdots$

constant and equal to its pre-reform levels (blue solid line), as well as 3) the actual trajectory followed by investment in the data (black dot-dashed line). One important first result from this counter-factual exercises is that, for the cases of capital, dividend and consumption taxes, the anticipation of higher future rates has a negative impact on current investment, even before the tax changes actually occur. This is precisely what we call the "fear of taxes" mechanism.

Furthermore, we observe in the Figure that the effect on investment is different for the case of each tax. Note first that, as expected by the analysis in section 3, the increase in the tax on capital has a permanent effect on investment (see equation 8): the red dashed line in the top-left panel in the Figure never reaches the level of the solid blue line after 2013, which is the level that would have occurred without the fiscal reform. Similarly, consumption taxes (in the bottom left panel) also have a permanent negative effect on the level of investment. The reason for this relies on a general equilibrium effect: consumption taxes affect the return to hours worked in the intra-temporal optimal condition (see equation 7), which ends up modifying the equilibrium rate of return on investment. This occurs, despite the fact that a constant consumption tax rate cancels out in the Euler equation. Note also the presence of a transitory negative effect of consumption taxes on investment in addition to this permanent effect. In particular, note that investment shows a larger decline in 2013 compared to the future periods. The reason for this is that the expected return in the Euler equation for 2013 (equation 8) is affected by the difference in the tax rates in the two consecutive periods (2013 and 2014). Finally, note that dividend taxes (in the top right panel) have only a temporary effect on investment, and that after the reform takes place, there is absolutely no damage on investment levels associated with this tax (the red and blue lines overlap on each other). This is a property of dividend taxes that –to our knowledge– has not been previously emphasized in the literature. Note that, in our model, dividend taxes –when constant over time– have absolutely no effect on steady state values, and its effects on the economy are only temporary, while they are introduced.[11]

In contrast to the effect of the three kind of tax rates previously analyzed, the bottom-right panel of the figure shows that the effect of the anticipation of higher labor taxes on investment is positive for the year 2013. The reason for this is the way in which the inter-temporal allocation of leisure is affected when higher labor taxes in the future are expected. In particular, note that the expected higher labor tax makes future leisure cheaper, thus the household reacts reducing leisure today, and working more.

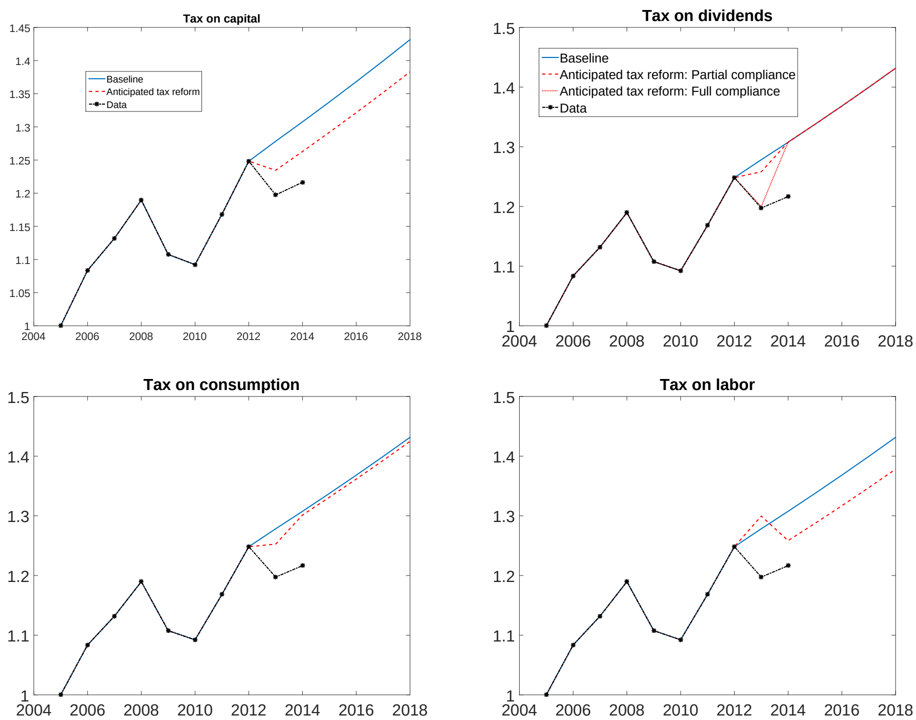
Finally, Figure 14 also shows (in the top right panel) that the effect of the dividend tax is sensitive to the assumed level of compliance. We assume that the level of compliance has a direct impact on the effective tax rate applied in the model. So, for example, if the level of compliance is 50% and the tax rate is 10%, the resulting effective tax rate is 0.05 (=0.5*.1). Although this way of proceeding is certainly a simplification, it is straightforward and easy to implement. Thus, when we assume full compliance for dividend taxes (dotted line), the effect of its introduction is too strong. Therefore, we have set the level of compliance of this newly introduced tax to be equal to the implicit level of compliance that we observe for the capital tax. The effect of the anticipation of higher dividend taxes when compliance is not perfect is shown by the dashed line in the figure. Note that this effect is more moderate.

Next, we present the effect of anticipating the tax reform (with certainty) when all taxes move jointly. We present the effect of this counter-factual on several aggregate variables[12] in Figure 15. The model is able to replicate the drop in investment observed in the data for 2013, as well as its subsequent partial recovery in 2014. Importantly, note that investment in the data does not recovers fully to its pre-reform levels, which is a feature that is also shared by the model. Additionally, the model follows closely the trajectory of GDP per working age population in the data. Note that we are able to replicate almost perfectly the GDP level in 2013, even without taking into account

[11] Of course, an important assumption is that the revenue associated with these taxes is given back to the household as a lump-sum transfer which keeps the feasibility constraint unaltered (see also footnote 6).

[12] We do not present the effect on aggregate consumption. The reason for this is that we know, by the previous work of McGrattan (2012), that when investment falls, consumption tends to increase. This is true in particular when TFP does not falls along. Thus, consumption in the model tends to show a counterfactual behavior in this type of exercise. We have decided to keep it out of the analysis for this reason.

Figure 14: Effect of anticipation on investments



Notes: The figure shows the observed real investment (2005=1) as well as the value that corresponds to different counter-factual exercises. The baseline value of investment in the model is the same as in the data (see the Calibration section for more details).

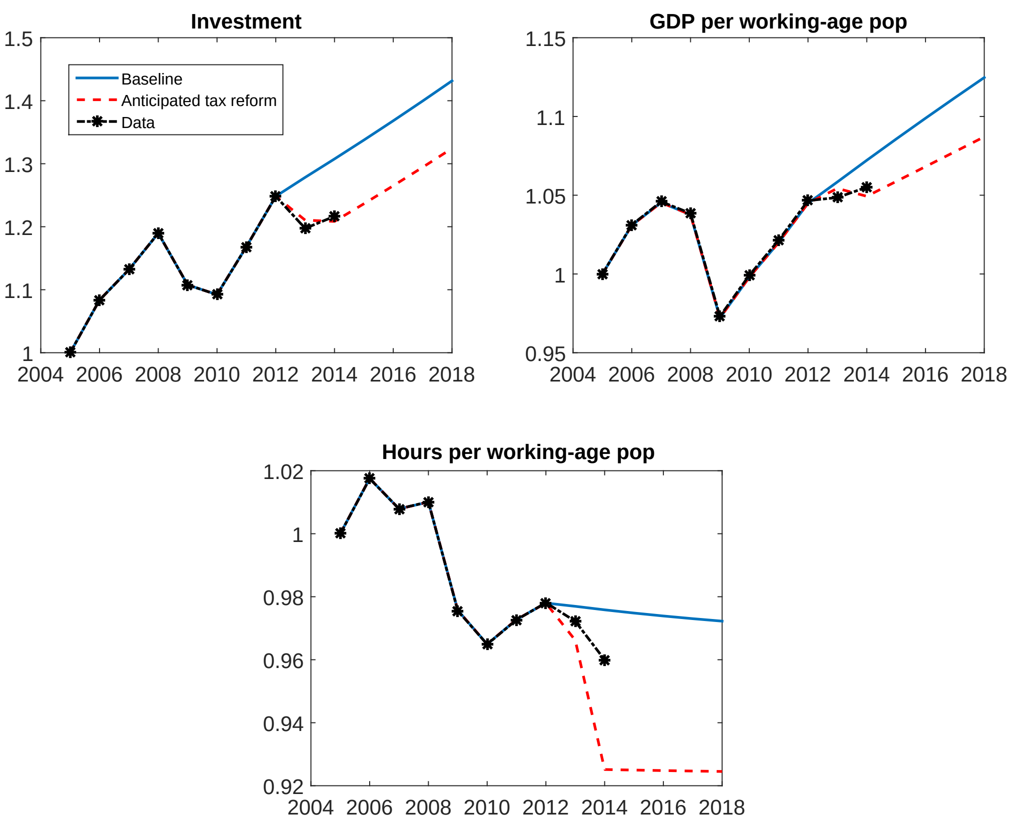
Table 5: Effective tax rates for Counter-factual Exercise 2

Expectations about future τ^c					
t	probability	2013	2014	2015	...
2012	100%	6.84%	6.84%	6.84%	...
2013	p	6.84%	6.84%	6.84%	...
	$1-p$	7.50%	7.50%	7.50%	...
2014	100%	7.50%	7.50%	7.50%	...
2015	100%	7.50%	7.50%	7.50%	...
⋮	⋮	⋮	⋮	⋮	⋮

the possible variation in total factor productivity in the data (we have assumed that productivity grows at a constant rate). The model is also close to the observed GDP level in 2014. On the negative side, note that the model overestimates the drop in hours worked per working age population relative to the data. Given that, in this exercise, we have only considered one source of business cycles it is not surprising that the model fails in explaining some aspects of reality. It is highly likely that other factors were also playing a role in defining macroeconomic variables during this period. For the case of hours worked, in particular, it is possible that the model overestimates the drop in hours because the change in labor taxes was not in the public discussions that led to the fiscal reform, and therefore it is unlikely that agents were able to anticipate this change. Moreover, the model does not takes into account the existence of an informal sector, which typically escapes taxation and helps to smooth employment fluctuations.

Case of uncertainty. In a second exercise we introduce “noisy expectations”: a situation where agents can not anticipate with certainty whether the reform would take place or not. In particular, we study the case where agents anticipate permanent higher taxes, but they believe that there is still a 50% chance that the reform would not take place. More precisely, they believe that the situation prevalent at the end of 2012 would remain permanently unaltered if the reform doesn’t takes place. Table 5 presents the evolution of expectations about future consumption taxes in this exercise, while the expectations for the rest of the taxes is presented in the appendix. Furthermore, we assume that regardless of agents beliefs, the reform indeed materializes in 2014, although this is not known with certainty in 2013. Thus, the problem solved by the agents in this case is not standard, in the sense that the recursive nature of the standard growth model is broken in 2013 and 2014.

Figure 15: Effect of anticipation on main aggregates



Notes: The figure shows the effect of anticipation on main aggregates (2005=1). It assumes that agents are able to anticipate the reform without uncertainty.

It is important to analyze the way in which the Euler equation is affected when uncertainty about future taxes is present. For this purpose, let us assume that up until the end of 2012, agents believed that taxes where going to stay constant and equal to the 2012 tax rate levels forever. However, starting in 2013, agents face uncertainty about future taxes. In particular, they believe that with probability p, a reform would take place, which would permanently increase taxes from 2014 onward. They also believe that with probability $(1-p)$ taxes would remain fixed to its 2012 levels forever.

For illustration purposes, let us focus on a generic output tax, τ, and assume the rest of the taxes are zero. Also, abstract from the effect of non-tax wedges by assuming that these are always equal to one. Agents believe that the reform, if enacted, would permanently increase taxes to a level τ^H. Thus, this level would be in place since 2014 onward: $\tau_{2014} = \tau_{2015} = \tau_{2016} = ... = \tau^H$. Alternatively, agents believe that taxes would remain permanently low if the reform does not takes place. In this case: $\tau_{2014} = \tau_{2015} = \tau_{2016} = ... = \tau^L < \tau^H$, where $\tau^L = \tau_{2012}$.

For illustration purposes, let us also abstract for now from the labor/leisure choice. Thus, the only relevant choice is how much to invest in each period. Notice that the capital that is used to produce in 2013 was decided one period before. In 2012, agents faced no uncertainty (see Table 5) regarding taxes. Similarly, in 2014, agents will know, with certainty, whether the reform took place or not. Since they believe that these changes are permanent, this means that from that date onward agents will no longer face uncertainty. As a matter of fact, the only choice facing uncertainty is how much to invest in 2013.

To solve the problem faced by agents in 2013, we proceed in the following way. First, we posit ourselves in 2014, and simulate the optimal equilibrium path for capital as if the reform would have not occurred. This is the same as solving for an economy starting in 2014 and facing the low tax rate, τ^L, forever. We do this for any given starting capital level k_{2014}. The optimal path of capital associated with this exercise is given by: $\left\{k_{2014}, k_{2015}^L, k_{2016}^L, ..., k_{T+1}^L\right\}$. Next, we repeat this exercise but assuming that the reform indeed took place and the economy faces a high tax rate, τ^H, from 2014 onward. We also do this exercise for any given starting capital k_{2014}. The resulting equilibrium path for capital with the reform is given by: $\left\{k_{2014}, k_{2015}^H, k_{2016}^H, ..., k_{T+1}^H\right\}$.

Remember that after 2014, agents would have already figured out whether the reform indeed took place or not, and the value of taxes would be known as well. The value function associated with the problem of the household at the beginning of 2014 is defined as follows. Taking as given initial capital (k_{2014}), and the tax rate τ^i, the problem for $i \in \{H, L\}$ is:

$$
\begin{aligned}
V(k_{2014}, \tau^i) \quad = \quad & \max_{\{c_t^i, k_{t+1}^i\}} \sum_{t=2014}^{T} \beta^{t-2014} ln(c_t^i) \\
& s.t. \\
& c_t^i = (1-\tau^i) f(k_t^i) - k_{t+1}^i + (1-\delta) k_t^i + Rev_t^i, \\
& \forall t = 2014, 2015, ..., T. \\
& k_{2014} \ and \ \tau^i, \ are \ given.
\end{aligned}
$$

Note that this is a simplified version of the same problem described in section 3. There is really no big difference between the two problems except for the fact that here, we are making explicit that the equilibrium path for capital varies depending on the tax rate faced and on the starting level of capital. This way of writing the problem in 2014 is useful to address the more complicated problem that the household faces in 2013. Let us now focus on the problem with uncertainty faced by the household in 2013:

$$
\begin{aligned}
& \max_{\{c_{20130}, k_{2014}\}} \left\{ ln(c_{2013}) + \beta p V(k_{2014}, \tau^H) + \beta(1-p) V(k_{2014}, \tau^L) \right\} \\
c_{2013} \quad = \quad & (1-\tau_{2013}) f(k_{2013}) - k_{2014} + (1-\delta) k_{2013} + Rev_{2013}, \forall t = 0, ..., T \\
& k_{2013} \ and \ \tau_{2013} = \tau^L, \ are \ given.
\end{aligned}
$$

Thus, in this period, the household is uncertain about the future tax rate she will face, and has to take into consideration what the optimal behavior would be in each possible scenario.

An equilibrium is a set of capital levels $\{k_{2014}, k_{2015}, k_{2016}, ..., k_{T+1}\}$ that, taking as given tax rates $\left\{\tau^L, \tau^H\right\}$ and initial capital k_{2013}, solves the following equilibrium conditions:

For $t = 2013$:

$$
\begin{aligned}
\frac{1}{c_t} &= p\beta\left(\frac{1}{c^H_{t+1}}\right)\left(1+\left(1-\tau^H_{t+1}\right)f'(k_{t+1})-\delta\right)+ \\
&\quad (1-p)\beta\left(\frac{1}{c^L_{t+1}}\right)\left(1+\left(1-\tau^L_{t+1}\right)f'(k_{t+1})-\delta\right)
\end{aligned} \tag{9}
$$

$$
\begin{aligned}
c_t &= f(k_t)-k_{t+1}+(1-\delta)k_t, \\
c^H_{t+1} &= f(k_{t+1})-k^H_{t+2}+(1-\delta)k_{t+1}, \\
c^L_{t+1} &= f(k_{t+1})-k^L_{t+2}+(1-\delta)k_{t+1},
\end{aligned}
$$

For $t \geq 2014$:

$$
\frac{1}{c^i_t} = \beta\left(\frac{1}{c^i_{t+1}}\right)\left(1+\left(1-\tau^i_{t+1}\right)f'(k^i_{t+1})-\delta\right)
$$

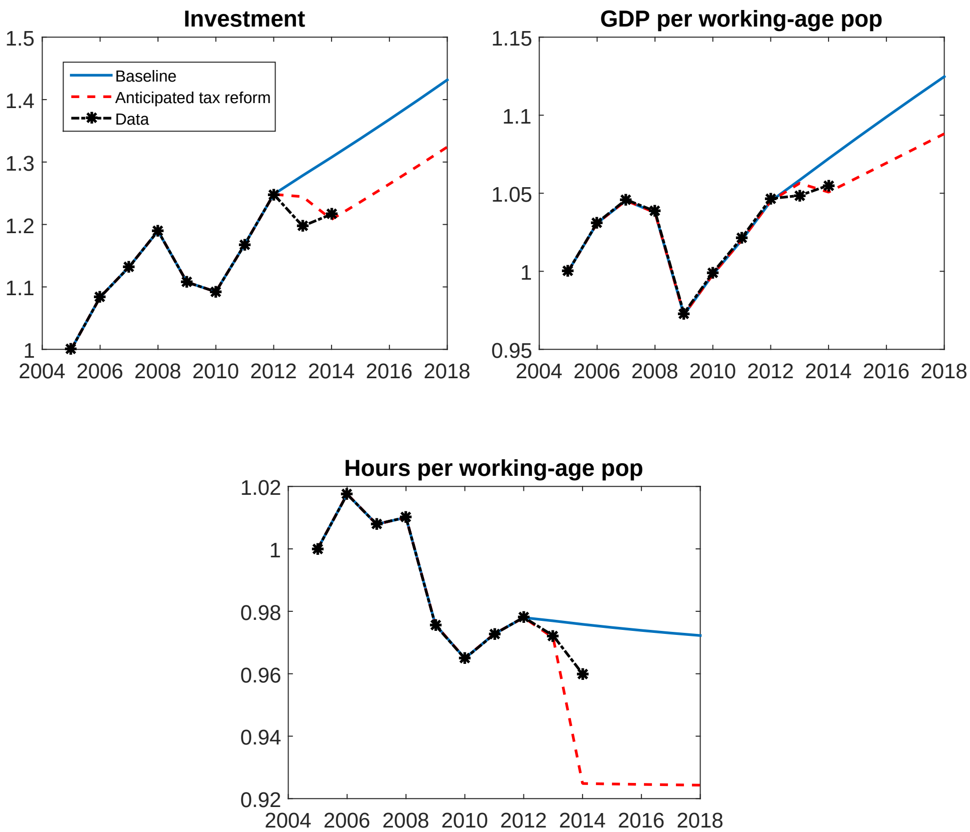
$$
c^i_{t+1} = f(k^i_{t+1})-k^i_{t+2}+(1-\delta)k^i_{t+1},
$$

where $i \in \{H, L\}$.

As can be observed in the equilibrium conditions, to obtain the optimal choice for k_{2014}, it is necessary to first obtain the optimal values of k^L_{2015} and k^H_{2015}. For that reason we solve this problem backwards. We first obtain the optimal sequence of capital choices for any given starting capital in 2014, k_{2014}, and for either of the two possible values of tax rates. Then, we use these sequences in the problem for the 2013 time period.

Figure 16 presents the macroeconomic effect of anticipating the tax reform with uncertainty. It is clear that, the introduction of "noisy" expectations does a poor job replicating the data compared to the exercise with certainty in Figure 15. The reason for this is that the expected real rate of return on investments is not reduced in 2013 as much as in the exercise with certainty. In the case of uncertainty, agents grant a large probability to the scenario of staying with low taxes. As a result, neither investment, nor hours, nor output decline in 2013 as much as in the case of certainty. Note also that from 2014 onward, the effect of the reform is the same as in the exercise with certainty.

Figure 16: Effects of anticipation with noisy expectations



Notes: The figure shows the effect of anticipation on main aggregates (2005=1). It assumes that agents have uncertainty regarding whether the reform will be implemented or not.

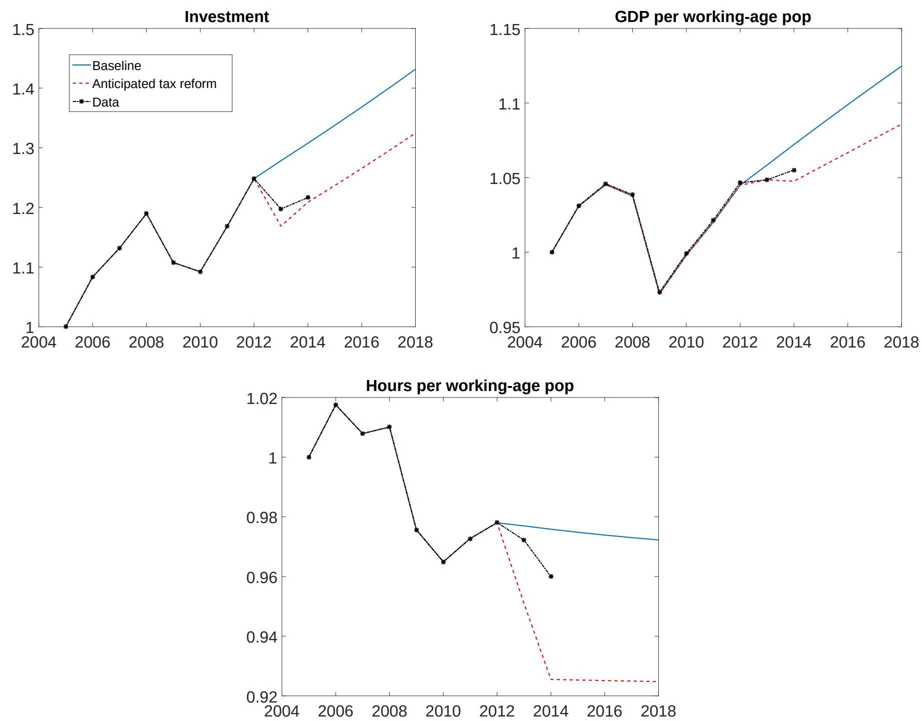
This is because after the reform is materialized agents no longer face uncertainty, as noted above.

One final counter-factual exercise performed consists on using the actual effective tax rates that were estimated in 2013. So far we have assumed that the tax rates of 2013 remained at the same level as in 2012. This exercise assumes that agents are surprised in 2013 with the new taxes, but that they are still able to anticipate the tax reform that starts in 2014. We proceed in this way because we believe that the changes in effective taxation in that year (2013) were mainly due to the arrival of a new administration. Table 6 presents the time series of taxes assumed in this exercise, and Figure 17 presents the effects of this scenario on the main aggregates. We observe that the main conclusions are unaltered when the actual tax rates in 2013 are used. One important reason for this

Table 6: Effective tax rates Counter-factual Exercise 3.

	τ_c	τ_l	τ_k	τ_d
2012	6.84%	25.60%	7.78%	0.00%
2013	6.30%	26.94%	10.26%	0.00%
2014	7.50%	29.12%	9.06%	2.33%
2015	7.50%	29.12%	9.06%	2.33%
$\vdots$	$\vdots$	$\vdots$	$\vdots$	$\vdots$

Figure 17: Effect of anticipation using actual effective tax rates in 2013

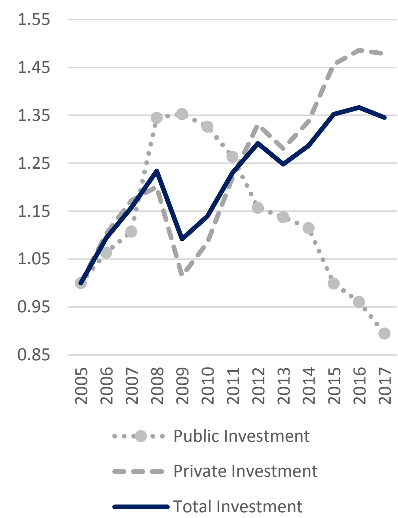


is that we are assuming that all tax changes in 2013 were unexpected. In particular, for the case of the tax on capital, the value of this tax in 2013 has no impact on the decisions of the agents in that year.

6 Discussion

In this section, we explore the possibility that other factors –in addition to the "fear of taxes" mechanism– could have also contributed to the fall in total investment registered in 2013. One alternative story concerns the evolution of public investment. Can the

Figure 18: The role of public investment in the 2013 fall of total investment.



reduction of total investment experienced in 2013 be explained by a significant reduction in public investment during that year? Figure 18 presents the evolution of total, private, and public investment between 2005 and 2017. We observe that both, private and total investment, evolve similarly during the entire period. Furthermore, 2013 does not seem to be an exception to this correlation. In particular, notice that private investment falls -3.8% during 2013, while total investment falls -3.4%. In contrast, the fall in public investment in that year is only -1.7%. Note also that in 2013 public investment represented only 20% of total investment in Mexico. Thus, the majority of the fall in total investment of 2013 is rooted in the corresponding fall of private investment. In general, the evolution of public investment has been quite erratic during the period. There is a dramatic drop in public investment after 2009 that still continues in the present. This has signified a reduction in the public investment share (in total investment) from 28% in 2009 to 15% in 2017. However, this evolution does not seem to have affected the path of total investment in the year 2013. The figure shows that there have been significant drops in public investment in 2011, 2012, 2015 and 2017, but not during 2013.

This discussion suggests that public investment played a small role in the reduction experienced by aggregate investment in 2013. Nevertheless, the arrival of a new administration to the federal government typically means that many investment projects and government expenditures are delayed while the new people in charge gets used to their new responsibilities. Thus, it is interesting to look more carefully into the drop of the components of investment. The case of Construction is illustrative as the value-added of this sector experienced a reduction in 2013. GDP of Construction has four main components: 1) Residential Construction, 2) Non-residential Construction, 3) Construction of Civil Engineering Projects, and 4) Specialized Construction Works. Roughly speaking, 50% of value added in this sector is given by Residential Construction, 20% by non-residential, another 20% by Civil Engineering Projects, and 10% by Specialized Construction Services. Within the component of Construction of Civil Engineering Projects there is the sub-component of "construction of urbanization works" where value added went down dramatically in 2013. Indeed, the value added in this sub-component went down 18% relative to its value added in 2012. In summary, although it seems that public investment did not played an important role, by looking into the details more carefully, the evidence suggests that the arrival of a new administration could have also played a role in the reduction of aggregate investment in 2013, along with the "fear of taxes" mechanism.

7 Conclusion

In this paper, we studied a recent fiscal reform in Mexico enacted in 2014. We documented that households had information in advance of the reform. Then, we made use of a macroeconomic model with taxes and wedges to investigate the role of anticipation. We showed that this channel can account for the drop in investment in 2013, as well as the drop in GDP.

In our model, there is a trade-off between paying dividends and investing: the more dividends are paid, the less resources are left to invest. The anticipation since 2013 of the introduction of a dividend tax in 2014 prompted firms to pay dividends sooner than previously planned, and to reduce investment as a consequence. In the model, this mechanism works through the rate of return on investment: a higher dividend tax in the future reduces the purchasing power of future dollars, making it more attractive to consume today, and less attractive to invest.

Also, in our model, the real rate of return on investment is affected by consumption taxes when these differ over time. For example, if consumption taxes are expected to be higher next period, this reduces the return of current investment because each dollar invested today will have a lower purchasing power tomorrow. Put it differently, a higher consumption tax tomorrow reduces the relative price of today's consumption.

One important property of dividend taxes is that these do not have an impact on equilibrium allocations in the long run. Thus, dividend taxes are the least distortionary of the four taxes analyzed here. Future research work should explore the possibility of fiscal reforms that switch the tax burden from distortionary taxes to dividend taxes.

References

Bergoeing, R., P. J. Kehoe, T. J. Kehoe, and R. Soto (2002): "A decade lost and found: Mexico and Chile in the 1980s," *Review of Economic Dynamics*, 5, 166–205.

Chari, V., J. P. Nicolini, and P. Teles (2016): "More on the optimal taxation of capital," in *2016 Meeting Papers*, Society for Economic Dynamics, 1364.

Chari, V. V., P. J. Kehoe, and E. R. McGrattan (2007): "Business cycle accounting," *Econometrica*, 75, 781–836.

Conesa, J. C., T. J. Kehoe, and K. J. Ruhl (2007): "Modeling great depressions: the depression in Finland in the 1990s," Tech. rep., National Bureau of Economic Research.

Gollin, D. (2002): "Getting income shares right," *Journal of political Economy*, 110, 458–474.

Hayashi, F. and E. C. Prescott (2002): "The 1990s in Japan: A lost decade," *Review of Economic Dynamics*, 5, 206–235.

McGrattan, E. R. (2012): "Capital Taxation During the U.S. Great Depression," *The Quarterly Journal of Economics*, 127, 1515–1550.

Mendoza, E. G., A. Razin, and L. L. Tesar (1994): "Effective tax rates in macroeconomics: Cross-country estimates of tax rates on factor incomes and consumption," *Journal of Monetary Economics*, 34, 297–323.

Meza, F. (2008): "Financial crisis, fiscal policy, and the 1995 GDP contraction in Mexico," *Journal of Money, Credit and Banking*, 40, 1239–1261.

Papageorgiou, D. (2012): "Fiscal policy reforms in general equilibrium: The case of Greece," *Journal of Macroeconomics*, 34, 504–522.

Rogerson, R. (2010): *The Impact of Labor Taxes on Labor Supply: An International Perspective*, AEI Press.

Appendix

Dividend taxes are isomorphic to a combination of consumption and labor taxes

In this section, we show the way in which equilibrium allocations in an economy with a dividend tax, can also be obtained using only consumption and labor taxes. The results are presented abstracting from the corporate income tax, but these are robust to assuming a time variant positive tax rate on corporations.

To begin the argument, note that the equilibrium allocations with dividend taxes are given by the following set of equations:

$$\frac{u_{l,t}}{u_{c,t}} = (1-\alpha)Ak_t^{\alpha}h_t^{-\alpha} \tag{10}$$

$$\frac{u_{c,t}}{\beta u_{c,t+1}} = \left(\frac{1-\tau_{t+1}^d}{1-\tau_t^d}\right)\left(1+\alpha A_t k_{t+1}^{\alpha-1}h_{t+1}^{1-\alpha}-\delta\right) \tag{11}$$

$$c_t + k_{t+1} - (1-\delta)k_t = A_t f(k_t, h_t) \tag{12}$$

Let the above economy, be called "Economy 1" and note that dividend taxes are the only taxes present. The question is whether there is a way to obtain the equilibrium allocations of Economy 1, using only consumption and labor taxes. To investigate this, let Economy 2 be given by an economy with only consumption and labor taxes, and no dividend taxes. The equilibrium conditions of Economy 2, are given by:

$$\frac{u_{l,t}}{u_{c,t}} = \left(\frac{1-\tilde{\tau}_t^l}{1+\tilde{\tau}_t^c}\right)(1-\alpha)A_t k_t^{\alpha} h_t^{-\alpha} \tag{13}$$

$$\frac{u_{c,t}}{\beta u_{c,t+1}} = \left(\frac{1+\tilde{\tau}_t^c}{1+\tilde{\tau}_{t+1}^c}\right)\left(1+\alpha A_t k_{t+1}^{\alpha-1} h_{t+1}^{1-\alpha} - \delta\right) \tag{14}$$

$$c_t + k_{t+1} - (1-\delta)k_t = A_t f(k_t, h_t) \tag{15}$$

where the tax rates corresponding to this economy are represented with a tilde. By comparison of 10-12, against 13-15 we conclude that given a time series of the dividend taxes in Economy 1, it is possible to choose the time series for consumption and labor taxes such that Economy 2 delivers the same equilibrium allocations as Economy 1. In particular given $\left\{\tau_t^d\right\}_{t=0}^{\infty}$ from Economy 1, it can be shown that the equilibrium of this economy can be replicated using Economy 2, by choosing the values of consumption and labor taxes in the following way:

$$1+\tilde{\tau}_t^c = \frac{1}{1-\tau_t^d} \tag{16}$$

$$\tilde{\tau}_t^l = -\tilde{\tau}_t^c \tag{17}$$

where we have used tildes to distinguish the tax rates in Economy 2 from those in Economy 1. By imposing the values of $\tilde{\tau}_t^l$ and $\tilde{\tau}_t^c$ to be given by the above two equations, we ensure that the equilibrium allocations in Economy 1 are replicated by Economy 2.

This result leads to the following corollary. Suppose we have an economy with only labor and consumption taxes. The question is now how to implement the introduction of new dividend taxes using only consumption and labor taxes. Let Economy A be the economy with consumption, labor and dividend taxes that we want to implement. The equilibrium conditions are given by:

$$
\begin{aligned}
\frac{u_{l,t}}{u_{c,t}} &= \left(\frac{1-\tau_t^l}{1+\tau_t^c}\right)(1-\alpha)Ak_t^{\alpha}h_t^{-\alpha} && (18) \\
\frac{u_{c,t}}{\beta u_{c,t+1}} &= \left(\frac{1+\tau_t^c}{1+\tau_{t+1}^c}\right)\left(\frac{1-\tau_{t+1}^d}{1-\tau_t^d}\right)\left(1+\alpha Ak_{t+1}^{\alpha-1}h_{t+1}^{1-\alpha}-\delta\right) && (19)
\end{aligned}
$$

where we have avoided re-writing the resource constraint, which is unaffected by taxes. Now let Economy B be affected only by consumption and labor taxes, and given by equations 13-15. It can be shown that the allocations of Economy A can be implemented by choosing the value of taxes in Economy B to be given by:

$$
\begin{aligned}
1+\tilde{\tau}_t^c &= \frac{1+\tau_t^c}{1-\tau_t^d} && (20) \\
\tilde{\tau}_t^l &= -\tilde{\tau}_t^c && (21)
\end{aligned}
$$

Next, consider the following related exercise. Assume starting values for consumption, labor, and capital taxes are given by $\left\{\tau_t^c, \tau_t^l, \tau_t^k\right\}$ for $t \leq s$. Then, at period $s+1$, a fiscal reform is introduced which permanently increases these taxes and a new permanent dividend tax is established. The tax rates associated with this reform are given by: $\left\{\tau_{s+1}^c, \tau_{s+1}^l, \tau_{s+1}^k, \tau_{s+1}^d\right\}$, which apply for all $t \geq s+1$. The question is whether there is a way to implement the allocations corresponding to this new equilibrium (with reform), without the need to explicitly introduce dividend taxes in the model. Thus, we look for alternative tax rates $\left\{\hat{\tau}_{s+1}^c, \hat{\tau}_{s+1}^l, \tau_{s+1}^k, \hat{\tau}_{s+1}^d = 0\right\}$ that implement the same allocation that is associated with the fiscal reform. Specifically, we would like to answer by how much do we need to increase consumption and labor taxes, such that we take into account not only the increase in these tax rates, but also the new dividend tax. Take the case of consumption taxes first. Assume the reform will increase consumption taxes by a factor $\theta^c = \tau_{s+1}^c/\tau_s^c$. Assume also that the new dividend tax is given by $\tau_{s+1}^d > 0$. Thus, we are looking for the factor $\hat{\theta}^c$, such that:

$$
\hat{\theta}^c = \hat{\tau}_{s+1}^c/\tau_s^c,
$$

$$1 + \hat{\tau}^c_{s+1} \;=\; \frac{(1 + \theta^c \tau^c_s)}{\left(1 - \tau^d_{s+1}\right)}.$$

Now, take the case of labor taxes. Assume that the reform increases labor taxes by a factor given by $\theta^l = \tau^l_{s+1}/\tau^l_s$. Thus, we are looking for the factor $\hat{\theta}^l$, such that:

$$\begin{aligned}
\hat{\theta}^l &= \hat{\tau}^l_{s+1}/\tau^l_s, \\
\frac{1 - \hat{\tau}^l_{s+1}}{1 + \hat{\tau}^c_{s+1}} &= \frac{\left(1 - \theta^l \tau^l_s\right)}{(1 + \theta^c \tau^c_s)}.
\end{aligned}$$

It can be showed that these factors are given by:

$$\hat{\theta}^c = \frac{\theta^c}{1 - \tau^d_{s+1}} + \left(\frac{1}{\tau^c_s}\right)\left(\frac{\tau^d_{s+1}}{1 - \tau^d_{s+1}}\right),$$

and

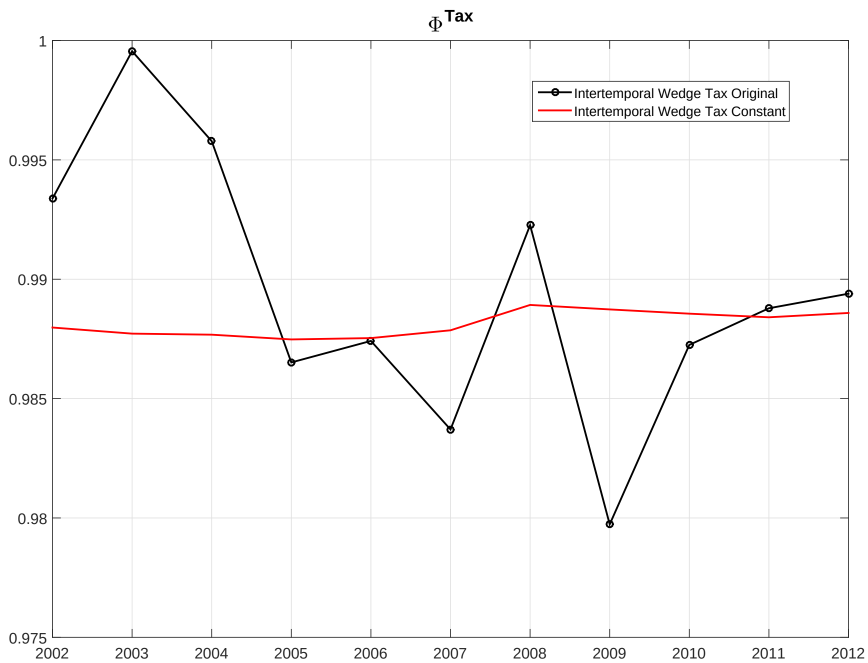
$$\hat{\theta}^l = \left(\frac{1}{\tau^l_s}\right)\left(\frac{\tau^d_{s+1}}{1 - \tau^d_{s+1}}\right) + \frac{\theta^l}{1 - \tau^d_{s+1}}.$$

Quantitative importance of TFP changes for the evolution of the inter-temporal tax wedge (Φ^{nontax}_t)

In this section, we analyze the importance of TFP fluctuations on the evolution of the inter-temporal tax wedge $\left(\Phi^{Tax}\right)$. As shown in the paper, the inter-temporal tax wedge is given by the equation:

$$\Phi^{Tax}_t \;=\; \frac{\left(\frac{1+\tau^c_t}{1+\tau^c_{t+1}}\right)\left(1 + \left(1 - \tau^k_{t+1}\right)\left(\alpha A_{t+1} K^{\alpha-1}_{t+1} h^{1-\alpha}_{t+1} - \delta\right)\right)}{1 + \alpha A_{t+1} K^{\alpha-1}_{t+1} h^{1-\alpha}_{t+1} - \delta}$$

Figure 19: Contribution of TFP to Φ^{nontax}



In order to understand the contribution of TFP we set capital and consumption taxes constant over time and compute the associated tax wedge. This feature will allow us to determine whether the dynamics of the wedge are determined mainly by the fluctuations of taxes or by the fluctuations of TFP. Figure 19 shows the calibrated tax wedge along with the new tax wedge built using constant consumption and capital taxes.

As we can see, the new tax wedge is almost flat, which means that most of the fluctuations in such wedge are driven by the fluctuations in tax rates.