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Santiago García-Verdú
Banco de México

Manuel Ramos-Francia
Banco de México

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On the Costs of Deflation: A Consumption-Based Approach*

Santiago García-Verdú[†]
Banco de México

Manuel Ramos-Francia[‡]
Banco de México

Abstract: Our interest is to understand the costs of deflation. Thus, we explore the extent to which deflationary risks have surged in a selected set of European economies. To that end, we develop a simple consumption-based asset pricing model and, based on it, we estimate a(n) (in)deflation risk premium. We find that our aggregate risk premium and a systemic financial stress indicator correlate negatively. The absolute values of their (time-averaged) risk premiums and their financial development indices correlate as well. Both relations are in line with our model. In addition, we estimate panel data regressions to explore the extent to which changes in the price and debt levels, are priced in by the (in)deflation risk premium. We generally find that deflation terms contributes negatively to such a premium and inflation positively. The magnitudes of the coefficients associated with deflation tend to be greater, compared to those associated with inflation. This suggests that deflationary costs are relatively larger than inflationary ones. We rationalize this cost asymmetry with the presence of a credit constraint under deflationary periods.

Keywords: Consumption-based asset pricing, Inflation, Deflation, Inflation Risk Premium, Deflation Risk Premium, Eurozone.

JEL Classification: G12, E31

Resumen: Nuestro interés es entender los costos de la deflación. Así, exploramos en qué medida los riesgos por deflación han surgido en un conjunto de economías europeas seleccionadas. Para tal fin, desarrollamos un modelo simple de valuación de activos basado en el consumo, y con base en él, estimamos una prima por riesgo (in)deflacionario. Encontramos que nuestra prima agregada y un indicador de estrés financiero sistémico se correlacionan negativamente. Los valores absolutos (de los promedios a través del tiempo) de las primas por riesgo y sus índices de desarrollo financiero se correlacionan de la misma manera. Ambas relaciones están en línea con nuestro modelo. Adicionalmente, estimamos regresiones de panel para explorar hasta qué punto los cambios en el precio y los niveles de deuda son valuados en la prima por riesgo (in)deflacionario. En general, encontramos que los términos de deflación contribuyen negativamente a dicha prima, y la inflación lo hace positivamente. Las magnitudes de los coeficientes asociados a la deflación tienden a ser más grandes, comparados con aquellos asociados a la inflación. Esto sugiere que los costos de la deflación son relativamente más grandes que los inflacionarios. Racionalizamos esta asimetría en costos con la presencia de una restricción en el crédito bajo periodos deflacionarios.

Palabras Clave: Valoración de activos basada en consumo, Inflación, Deflación, Prima por Riesgo Inflacionario, Prima por Riesgo Deflacionario, Eurozona

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[†] Banco de México. Email: sgarciav@banxico.org.mx.

[‡] Banco de México. Email: mrfran@banxico.org.mx.

> *"The population is not distributed between debtors and creditors randomly. Debtors have borrowed for good reasons, most of which indicated a high marginal propensity to spend [...]. Typically their indebtedness is rationed by lenders, not just because of market imperfection but because the borrower has greater optimism about his own prospects [...], than the lender regards as objectively and prudently justified". (Tobin, 1980)*

1. Introduction

During some of the past few years, we have observed deflationary episodes and perspectives thereof in various European economies. While deflation may evoke negative recollections associated with specific historic episodes, it is not necessarily an adverse element for an economy. In effect, deflation has historically taken place under different economic settings, and the negative relation between deflation and output registered during the Great Depression is not always present (e.g., see Borio et al., 2015).[1] Nonetheless, we should be concerned about the conditions under which deflation is likely to entail economic costs.

Against this backdrop, we argue that key to the costs deflation might comprise are the levels and types of debts, along with the development of financial markets. In effect, changes in the price level lead to variations in the real resources that debtors need to pay nominal debts. From the point of view of an economy, changes in the price level might have distributional and wealth effects. In tandem, in more developed financial markets, agents are in a better position to protect themselves against shocks in general, including those to the price level.[2] In the context of the European Debt Crisis and its aftermath, we think that these points are worth examining, particularly so, to have a better understanding of the potential costs deflation might entail.

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[1] Buiter (2004) makes a comparison between the relationship between deflation and output, and the identification of changes in the price of a good. In effect, a decrease in its price might be associated with a decrease in demand, and thus a reduction in its quantity, or it might be associated with an increase in supply, and thus an increase in its quantity. One could empirically identify such shocks with several methodologies; for instance, see Blanchard and Quah (1989).

[2] Thus, our model relates to the debt-deflation theory first proposed in Fisher (1933).

Of course, this is one among other mechanisms that can shape the costs of (in)deflation. As an example, one very relevant from the onset of the Great Financial Crisis, consider that if nominal interest rates are near or at the zero lower bound and deflation sets in, then real interest rates would increase, affecting aggregate demand adversely. While we acknowledge that this mechanism, inter alia, might be relevant to the economic costs of deflation, we do not consider it here.

In our model, in which we only consider debtors explicitly, inflation is favorable to them since it dilutes the value of their debt. On the other hand, it is unfavorable to creditors, which are not as financially constrained. Likewise, deflation is unfavorable to debtors, and favorable to creditors. In general, debtors tend to have a higher marginal propensity to spend, as underscored by the epigraphic quote from Tobin. There is then an asymmetry in terms of the degree of financial restriction the agent might have, which implies that deflation -compared to inflation- can lead to greater costs. In short, under a deflationary episode, creditors might be more concerned about the debtors' ability to pay them back. We find evidence consistent with this point.

To explore some of the effects variations in the price level have, besides debt, we think it is relevant to consider the prevalent types of debt. For instance, from the point of view of an economy, changes in the price level in the presence of domestic debt would mostly lead to income redistribution. Variations in the price level under external debt would more likely result in changes in the economy's income, everything else being constant.[3]

Of course, elements such as debt denomination, maturity, and duration, could also be relevant to examine such effects. Thus, to focus on nominal debt, in one of our key exercises, we only consider economies from the Eurozone that have issued debt denominated mostly in euros. However, we do not explicitly consider its maturity and duration.

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[3] For instance, to assess the creditors' and debtors' net changes in wealth one should also consider variations in the real exchange rate.

In this context, the distinction between expected and unexpected inflation might be pertinent. In essence, any nominal debt contract generally contains an implicit expected inflation rate. Hence, deviations of inflation from its expectation bear on who benefits and who is adversely affected. In our case, we do not consider such a distinction explicitly. It is, however, an important topic in its own right (see, e.g., Cecchetti and Schoenholtz, 2015).

(In)deflation risk can be measured using several methodologies. A common one uses expected inflation, nominal, and real interest rates. The risk premium is defined as the nominal interest rate minus the real interest rate plus the expected inflation in period t, with all rates having a common horizon n, i.e., $y_{t,n} - (r_{t,n} + E_t(\pi_{t,n}))$.[4] Since a bondholder is uncertain about the real return of the nominal bond, one can interpret such a premium as a compensation.[5] This is generally an appealing approach, implemented, e.g., by García and Werner (2010). However, it relies on having a measure of expected inflation and, importantly, real interest rates associated with index-linked bonds.[6] Generally, the latter are not available for all economies, since the associated bond markets are either illiquid or nonexistent.

Another possibility is to obtain the inflation density implicit in the derivatives that have inflation as their underlying rate (e.g., see Fleckenstein et al., 2013). This method uses derivatives market data, which can likewise be either illiquid or nonexistent. Based on this approach, one can obtain the complete inflation density. In sum, these two methods work well if the respective data are available, which is not necessarily the case for some individual economies. In effect, their implementations are usually for large economies. We note that investing in nominal bonds involves other risks, such as credit and liquidity ones. Albeit these are important, we solely focus on (in)deflation risk.

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[4] We have two additional comments. First, the expected inflation is conditional on the information available at time t. Second, the interest rates are those associated with zero-coupon bonds.

[5] A possible extension of this approach considers liquidity premium for nominal and real bonds.

[6] In addition, index-linked bonds do not strictly yield a real return since the price index determining their return is available only with a time lag.

The literature has explored the inflation risk premium with various goals in mind. For instance, Söderlind (2011) analyzes the evolution of U.S. break-even inflation (i.e., $y_{t,n} - r_{t,n}$) from 1997 to mid-2008 as a function of survey data on inflation uncertainty and proxies for a liquidity premium. He highlights some key differences between expected inflation, inflation risk premium, and a measure of liquidity premium.

Christensen et al. (2012) construct probability forecasts for price deflation episodes using nominal and real U.S. bonds. They identify two deflationary episodes, a mild one after the 2001 recession, and a harsher one in 2008. Relatedly, Hördahl and Tristiani (2014) use a joint macroeconomic and term structure model to estimate the inflation risk premium and inflation expectations in the U.S. and the euro area. They argue that after 2004, the U.S. and euro area's inflation risk premiums have had similar dynamics.

On our part, we use a standard consumption-based asset pricing model. In it, the (in)deflation risk premium depends on the extent to which holding a nominal bond is conducive to a smooth consumption inter-temporally and across-states. Hence, such a model frames (in)deflationary risks in terms of their relation to consumption growth. Inflation and consumption data are, in general, readily available for most economies, although compared to financial data, the frequencies at which they are available are notably lower. Evidently, such models have their limits (e.g., see Mehra, 2012).

Anticipating our results, we have the following comments. We first document that our aggregate (in)deflation risk premium and a systemic financial stress indicator correlate negatively. In effect, deflation affects debtors adversely. We also find that the economies' indices of financial development and the absolute values of their (time-averaged) risk premiums correlate negatively. In our model, the more assets an agent has access to, the better her hedging capabilities and, thus, smaller risk premiums will prevail.

Second, the costs of deflation, as captured by the deflation risk premium, seem to be proportionally greater than those of inflation. In our model, a financial constraint is more likely to bind during deflationary episodes, increasing the magnitude of the referred premium.[7]

We divide the rest of our paper into the following sections. The second section explains the simple model we develop as a framework of our analysis. The third section describes the data and presents their main statistics. The fourth one provides the panel regression models and their interpretation. The last section offers some concluding remarks.

2. The Model

We use a representative agent endowment economy model (Lucas, 1978) with two periods, t and $t+1$. We assume, in turn, three possible financial market structures:

i) A market with all Arrow-Debreu securities and a non-contingent nominal bond (i.e., a complete market);[8]

ii) A market with a proper subset of the Arrow-Debreu securities, denoted by I and a non-contingent nominal bond (i.e., an incomplete market);[9] and,

iii) A market with a proper subset of the Arrow-Debreu securities, denoted by I, a non-contingent nominal bond and a credit constraint (i.e., an incomplete market).

In ii) and iii), we think of the set I as fixed but arbitrary, and assume that I and the nominal bond do not complete the market. These, accordingly, lead to three different kinds of budget constraints in period t:

i) $P_t C_t + D_t = P_t W_t + \mathrm{A}_t + \sum_{s=1}^{S} \alpha(s)\, B_t(s)$;

ii) $P_t C_t + D_t = P_t W_t + \mathrm{A}_t + \sum_{s \in I} \alpha(s)\, B_t(s)$;

iii) $P_t C_t + D_t = P_t W_t + \mathrm{A}_t + \sum_{s \in I} \alpha(s)\, B_t(s)$ and

$max_s(\boldsymbol{\alpha}(s)\boldsymbol{B_t}(s)/P_t) \leq \theta \mathbb{E}_t[W_{t+1} - D_{t+1}/P_{t+1}]$.

The respective budget constraints in period $t+1$ are:

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[7] These results are broadly consistent with those in Fleckenstein et al. (2013), in which they study deflation risk.

[8] Of course, there is one redundant asset.

[9] By a proper set, we mean that I is such that $I \subseteq \{e_1, e_2, \dots, e_S\}$ but $I \neq \{e_1, e_2, \dots, e_S\}$, where the elements e_s denote the Arrow-Debreu securities, and S is the total number of states of nature.

i) $P_{t+1}(s')C_{t+1}(s') + D_{t+1} + \alpha(s') + \mathrm{A}_t(1+i_t) = P_{t+1}(s')W_{t+1}$ for all $s' \in S$;

ii) $P_{t+1}(s')C_{t+1}(s') + D_{t+1} + \alpha(s') + \mathrm{A}_t(1+i_t) = P_{t+1}(s')W_{t+1}$ for all $s' \in I \subset S$;

iii) $P_{t+1}(s')C_{t+1}(s') + D_{t+1} + \alpha(s') + \mathrm{A}_t(1+i_t) = P_{t+1}(s')W_{t+1}$ for all $s' \in I \subset S$;

where C_t is the agent's consumption in period t, $C_{t+1}(s')$ is her consumption in state s', W_t is her endowment, A_t is the number of nominal bonds bought ($A_t < 0$), i_t is the interest rate on the nominal bond, D_t is the exogenous nominal debt ($D_t > 0$), and P_t is the price level. We note that D_t and P_t are exogenous variables. In addition, $\alpha(s)$ is the number of Arrow-Debreu security s the agent buys (if $\alpha(s) < 0$) or sells ($\alpha(s) > 0$), and $B_t(s)$ is its price, with s equal to $1,2,3,\ldots,S$, depending on the market structure.[10] The Arrow-Debreu security s' costs $B_t(s')$ and pays one unit of money if state s' occurs and zero in other states. The price level P_{t+1} is an exogenous random variable.[11] In fact, it is the only source of uncertainty in the model. We represent the agent's asset holdings in a vector $\boldsymbol{\alpha} \equiv (\mathrm{A}, \alpha(1), \alpha(2), \alpha(3), \ldots, \alpha(S))^{\mathrm{T}}$, where the superscript T denotes its transpose, in the complete markets case. Similarly, $\widehat{\boldsymbol{\alpha}}$ represents her asset holdings in the incomplete markets cases. Thus, its dimension is strictly smaller than $S+1$. Also, θ is a pledgeability parameter, with $0 < \theta < 1$, as we explain in more detail below. The debt, bond, and Arrow-Debreu securities are in nominal terms.

The agent maximizes the following utility function with respect to $\boldsymbol{\alpha}$ in the complete markets case, and with respect to $\widehat{\boldsymbol{\alpha}}$ in the incomplete markets cases:

$$u(C_t) + \beta \mathbb{E}_t(u(C_{t+1}))$$

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[10] In other words, a positive $\alpha(s)$ means that the agent is selling security s, i.e., borrowing; and a negative one means that she is buying it, i.e., saving.

[11] The singleton ω_{t+1} is an element of the sample space Ω with cardinality S. The subscript s is associated with a unique element in Ω. We thus consider a probability space (Ω, F, P), where F, the σ-algebra, is given by 2^{Ω}. We focus on the singleton elements in F and associate each one with the corresponding Arrow-Debreu security $\{s_1, s_2, \ldots, s_S\}$.

subject to the respective budget constraint i); ii); or, iii). The subjective discount factor is β with $0 < \beta < 1$, and $\mathbb{E}_t$ is the expectation conditional on information at time t.

Having described the main elements of our model, we analyze the covariance between consumption growth and inflation for each market structure in turn. As we will explain, this covariance has a direct relationship with the (in)deflation risk premium.

2.1. Complete Markets

Under complete markets, we have the following Euler equations, obtained from the first order condition with respect to each $\alpha(s)$ for $s = 1,2,3,\ldots,S$.

$\mathbb{E}_t[\beta(u'(C_{t+1})/u'(C_t))(1_{t+1}/P_{t+1})] = B_t(s)/P_t$ for $s = 1,2,3,\ldots,S$.

We note that the covariance between consumption growth and (in)deflation is zero if all securities have actuarially fair prices.[12] To see this, consider the Euler equation of a given Arrow-Debreu security s.

$$\beta(u'(C_{t+1}(s))/u'(C_t))q(s)/P_{t+1}(s) = B_t(s)/P_t$$

where *q(s)* is the probability of state s. Since we have assumed that all securities have actuarially fair prices, it follows that $u'(C_{t+1}(s))/u'(C_t) = 1$ and $C_{t+1}(s) - C_t = 0$. Thus, $C_{t+1}(s) = C_{t+1}(s')$ for all $s = 1, 2, 3, \ldots, S$, which implies that $\mathbb{cov}_t(\Delta c_{t+1}(\boldsymbol{\alpha}^{CM}), \pi_{t+1}) = 0$. Where we have that, $\Delta c_{t+1} = \log(C_{t+1}/C_t)$ is consumption growth, $\pi_{t+1} = \log(P_{t+1}) - \log(P_t)$ is inflation and $\boldsymbol{\alpha}^{CM}$ is the vector that solves the optimization problem. The superscript CM stands for complete markets. As mentioned, the non-contingent nominal debt is a redundant asset in this case. Still, we can obtain its associated Euler equation.

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[12] In a two period model, a security has an actuarially fair price if it is equal to its expected discounted pay-off. Thus, in the context of our model and in the case of an Arrow-Debreu security this happens if $(\beta/P_{t+1}(s))q(s) = B_t(s)/P_t$, where $q(s)$ denotes the probability of state s occurring.

$$\beta\mathbb{E}_t[(u'(C_{t+1})/u'(C_t))(P_t/P_{t+1})] = (1+i_t)^{-1}\ .$$

2.2. Incomplete Markets

Consider the market structure with a proper subset of all Arrow-Debreu securities I. As first order conditions we have:

$$\beta(u'(C_{t+1})/u'(C_t))q(s)/P_{t+1}(s) = B_t(s)/P_t \text{ for all } s \in I.$$

By the same token, assuming that all Arrow-Debreu prices are actuarially fair, we obtain that $u'(C_{t+1}(s))/u'(C_t) = 1$ and $C_{t+1}(s) - C_t = 0$ for all $s \in I$. Hence, $C_{t+1}(s) = C_{t+1}(s')$ for all $s \neq s'$ and $s, s' \in I$. However, for those $s \notin I$, we have that $C_{t+1}(s) - C_t \neq 0$. This implies:

$$0 \leq \left|\mathbb{cov}_t\left(\Delta c_{t+1}\left(\widehat{\boldsymbol{\alpha}}^{IM}\right), \pi_{t+1}\right)\right|,$$

where $\widehat{\boldsymbol{\alpha}}^{IM}$ is the portfolio that solves the optimization problem under incomplete markets. Similarly, the superscript *IM* stands for incomplete markets.

Note that one cannot characterize the sign of $\mathbb{cov}_t\left(\Delta c_{t+1}\left(\widehat{\boldsymbol{\alpha}}^{IM}\right), \pi_{t+1}\right)$ directly. To see this, consider those states for which the agent cannot perfectly insure.

$\beta(u'(C_{t+1})/u'(C_t))q(s)\ /P_{t+1}(s)\ < B_t(s)/P_t$, i.e., she cannot borrow for s.
$\beta(u'(C_{t+1})/u'(C_t))q(s)\ /P_{t+1}(s)\ > B_t(s)/P_t$, i.e., she cannot save for s.

Whether she can or cannot save or borrow for a specific state depends on the existence of the associated Arrow-Debreu security. Finally, the Euler equation for the nominal bond is:

$$\beta\mathbb{E}_t[(u'(C_{t+1})/u'(C_t))(P_t/P_{t+1})] = (1+i_t)^{-1}.$$

2.3. Credit Constraint

We motivate the credit constraint by the creditor's concern that the debtor (i.e., the agent) might not have the capacity, or the incentives, to honor her debts under some contingencies. In our model, such a concern heightens under deflationary episodes and debt. In such a case, the agent will need more resources to repay her debt. To capture this, we add to her problem the following credit constraint in period t.

$$max_s(\boldsymbol{\alpha}(s)\boldsymbol{B_t}(s)/P_t) \leq \theta\mathbb{E}_t[W_{t+1} - (D_{t+1}/P_{t+1})]$$

In short, a fraction of her net expected wealth in period $t + 1$ bounds its maximum Arrow-Debreu security, which she owes.

Note that its price implicitly accounts for the probability of the respective state. Since the debtor knows that the creditor will not grant her additional resources if the inequality binds, she considers it part of her own constraints. Under a deflationary environment (i.e., a higher value of $\mathbb{E}_t[P_t/P_{t+1}]$) and a higher debt D_t, the bound would become tighter.

We interpret θ as a pledgeability parameter with $0 \leq \theta \leq 1$. It represents the fraction of the expected net endowment to which the creditor can have direct access in case of a contingency. In practice, it depends on several factors, such as the information possessed by the creditor and its capacity to enforce contracts, among other several factors. This notion of pledgeability is similar to that of Diamond et al. (2016).[13]

The creditor is not willing to lend more than a fraction of the borrower's expected net endowment. Hence, if θ is small, it reflects a higher concern, tightening the constraint. On the other hand, a sufficiently large θ might lead to an unbinding constraint. There is also the possibility in which the agent's portfolio position is such that the constraint does not bind.[14]

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[13] Our and their contexts are quite different. Ours refers to aggregate debt/credit in an economy, while theirs to debt/credit in a corporation.

[14] The credit constraint is similar to, e.g., the one posited in Aiyagari and Gertler (1999).

In addition, we assume that θ is sufficiently small such that the credit constraint effectively binds for at least one $s' \in I$.

Hence, the first order conditions for this problem are:

$\beta(u'(C_{t+1})/u'(C_t))q(s)\ /P_{t+1}(s) \leq\ B_t(s)/P_t$ for all $s \in I$, having a strict inequality if the

agent cannot borrow enough and $(\boldsymbol{\alpha}(s)B_t(s)/P_t) = \theta\mathbb{E}_t[W_{t+1} - (D_t/P_{t+1})]$.

The Euler equation associated with the nominal bond is:

$$\beta\mathbb{E}_t[(u'(C_{t+1})/u'(C_t))(P_t/P_{t+1})] = (1+i_t)^{-1}.$$

When also facing a credit constraint, the agent will generally insure in less states than when facing only incomplete markets, thus,

$$\left|\mathbb{COV}_t\left(\Delta c_{t+1}(\widehat{\boldsymbol{\alpha}}^{IM}), \pi_{t+1}\right)\right| \leq \left|\mathbb{COV}_t\left(\Delta c_{t+1}(\widehat{\boldsymbol{\alpha}}^{IM+CC}), \pi_{t+1}\right)\right|, \qquad (1)$$

where $\widehat{\boldsymbol{\alpha}}^{IM+CC}$ is the portfolio that solves the optimization problem under incomplete markets and the presence of the credit constraint. Similarly, the superscript $IM + CC$ stands for incomplete markets plus the credit constraint. Moreover, if the credit constraint does not bind, then such covariances are equal.

To gain some intuition, we have the following remarks. Any portfolio that is feasible under problem iii) is also feasible under problem ii). Given the assumption of actuarially fair prices, the agent will insure herself in every state she can. In particular, for every state she insures for in problem iii), she will also do so in problem ii). However, there might be states in ii) for which she insures for, but she does not in iii). Accordingly, if there is one or more states of nature against which the agent cannot insure for, then she will not be able to smooth her consumption as much as she would like to, in effect, increasing the covariance between consumption growth and inflation. If there are additional states of nature against which she cannot insure because of a binding credit constraint (in our case, a binding pledgeability factor), then less consumption smoothing would take place, increasing the magnitude of the covariance between consumption growth and inflation.

Some additional comments are in order. First, in the model, a greater covariance's magnitude can be a product of a tighter credit constraint or of a less developed financial market. The identification of their relative importance is an important problem, and while we ponder the presence of both factors, we do not intend to determine their relative contribution.

Second, the model does not distinguish between different types of debts. However, as mentioned, these might be relevant in terms of the kind of economic costs one could observe given changes in the price level. Consequently, we estimate separate data panel regressions using different types of debts, as we explain in more detail below.

Third, the sign of the covariance between output and inflation varies (see, e.g., Plosser, 2003, Borio and Filardo, 2004, Borio et al., 2015). Of course, this also depends on the time frequency considered (e.g., see Walsh, 2010).[15] Our model is mute about its sign, and we do explore their relationship here.

2.4. The (In)Deflation Risk Premium

We next derive the (in)deflation risk premium, and show that the covariance between consumption growth and inflation has a direct relationship to it. To see this, consider the real return implied by our problem:[16]

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[15] For instance, at business cycle frequencies, one can think that if output correlates negatively with inflation, aggregate supply shocks are dominant. On the other hand, if output correlates positively with inflation, then aggregate demand shocks predominate. There is a large consensus that their correlation at a low frequency is close to zero, e.g., see McCandless and Weber (1995).

[16] This is akin to a real bond, e.g., known as Treasury Inflation Protected Securities (TIPS) in the U.S., and as index-linked Gilts in the U.K.

$$\beta\mathbb{E}_{\mathrm{t}}[u'(C_{t+1})/u'(C_t)] = \exp(-r_t)$$

In addition, reconsider the first order condition associated with the nominal bond,

$$\beta\mathbb{E}_t[(u'(C_{t+1})/u'(C_t))(P_t/P_{t+1})] = \exp(-i_t)$$

where $\exp(-r_t)$ denotes the price of a bond which pays one unit of consumption in period $t+1$ and $\exp(-i_t)$ is the price of a bond that pays one unit of money in period $t+1$ in all states. Note that we have used interest rates in continuous compounding to simplify our derivations.

Moreover, assuming a constant relative risk-aversion (CRRA) utility function $U(C_t) = (C_{t+1}^{1-\gamma})/(1-\gamma)$ would yield.

$$\beta\mathbb{E}_t[\exp(-\gamma\Delta c_{t+1} \qquad)] = \exp(-r_t) \tag{2}$$

$$\beta\mathbb{E}_t[\exp(-\gamma\Delta c_{t+1} - \pi_{t+1})] = \exp(-i_t) \tag{3}$$

where γ is the coefficient of relative risk aversion. We express (3) as follows:[17]

$$\beta\mathbb{cov}_t[\exp(-\gamma\Delta c_{t+1}), \exp(-\pi_{t+1})] + \beta\mathbb{E}_t[\exp(-\gamma\Delta c_{t+1})]\mathbb{E}_t[\exp(-\pi_{t+1})] = \exp(-i_t)$$

We then use (2), to obtain:

$$\beta\mathbb{cov}_t[\exp(-\gamma\Delta c_{t+1}), \exp(-\pi_{t+1})] + \exp(-r_t)\,\mathbb{E}_t[\exp(-\pi_{t+1})] = \exp(-i_t) \tag{4}$$

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[17] For this step, we have used the equality $\mathbb{cov}_t(X,Y) = \mathbb{E}_t(XY) - \mathbb{E}_t(X)\mathbb{E}_t(Y)$.

One could interpret (4) as a generalization of the Fisher equation.[18,19] Moreover, using the Taylor expansion of the exponential function around zero, and assuming that its higher order terms and the cross-terms in the second component are negligible, we can then obtain a simplified version of (4):

$$-\beta\gamma\mathbb{cov}_t(\Delta c_{t+1}, \pi_{t+1}) + r_t + \mathbb{E}_t\pi_{t+1} = i_t. \tag{5}$$

Hence, the term $-\beta\gamma\mathbb{cov}_t[\Delta c_{t+1}, \pi_{t+1}]$ can be seen as an (in)deflation risk premium.[20]

Importantly, we note that in this model, the risk premium or excess return of the nominal bond is equal to the (in)deflation risk premium. In effect, given that the only source of uncertainty in the model is the price level, they coincide.

In our previous derivation, we have assumed that higher order terms are negligible. To consider the possible role of prudence, one can take the marginal utility's Taylor expansion in period $t+1$ up to its second-degree term. This implies the following approximation for the stochastic discount factor.

$$\beta\frac{u'(C_{t+1})}{u'(C_t)} \approx \beta + \beta\frac{u''(C_t)(\Delta C_{t+1})C_t}{u'(C_t)C_t} + \beta\frac{u'''(C_t)(\Delta C_{t+1})^2 u''(C_t)C_t^2}{2u'(C_t)u''(C_t)C_t^2}$$

In this last expression, we have multiplied and divided the second term by C_t and the third term by $u''(C_t)C_t^2$. Using a CRRA utility function, one can rewrite this last equation as:

$$\beta\frac{u'(C_{t+1})}{u'(C_t)} = \beta - \beta\gamma\Delta C_{t+1}/C_t + \beta\gamma\rho(\Delta C_{t+1})^2/C_t^2$$

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[18] The Fisher equation is $(1+r_t)(1+\mathbb{E}_t\pi_{t+1}) = (1+i_t)$, i.e., it assumes that there is no (in)deflation risk premium.

[19] The same relationship more generally holds with a covariance term of the form $\beta\mathbb{cov}_t[M_{t+1}, \exp(-\pi_{t+1})]$ where M_{t+1} is a stochastic discount factor.

[20] Since $\mathbb{E}_t\pi_{t+1}$, the expected inflation conditional on the information at time t is known at t, we can rewrite the risk premium as $-\beta\gamma\mathbb{cov}_t[\Delta c_{t+1}, \pi_{t+1} - \mathbb{E}_t\pi_{t+1}]$; interpreting $\pi_{t+1} - \mathbb{E}_t\pi_{t+1}$ as an inflation surprise.

where $\rho = -u'''(C_t)C_t/u''(C_t)$ is the coefficient of relative prudence (Kimball, 1990). Such a coefficient measures the prudence of the agent and accounts for precautionary savings. Assuming a CRRA utility function, it equals $1+\gamma$, associating the relative risk-aversion (i.e., γ) and prudence coefficients.

Using this approximation, the first order condition associated with the nominal bond and the real return defined above, we obtain:[21]

$$\mathrm{i_t} = \mathrm{r_t} + \mathbb{E}_t \mathrm{\pi_{t+1}} \underbrace{-\beta\gamma \mathbb{cov}_t(\Delta c_{t+1}, \mathrm{\pi_{t+1}}) + \beta\gamma\rho \mathbb{cov}_t((\Delta c_{t+1})^2, \mathrm{\pi_{t+1}})/2}_{\text{(In)Deflation Risk Premium}} \quad (6)$$

In sum, accounting for prudence adds a term to the first (in)deflation risk premium we initially considered. Its contribution to such a premium depends on the sign of $\mathbb{cov}_t((\Delta c_{t+1})^2, \mathrm{\pi_{t+1}})$. We will have more to say about its implications below.

2.5. Discussion

We next summarize the role played by key exogenous variables in the determination of the (in)deflation risk premium. We note that unless otherwise stated, we assume that markets are incomplete and that the agent is a debtor.

Nominal Debt

The real value of nominal debt depends negatively on inflation. In effect, more inflation eases the agent's debt burden, providing her with more resources. Thus, nominal debt should contribute negatively to the (in)deflation risk premium.

Analytically, this result derives from the budget constraint. In effect, we have that $\mathbb{cov}_t(\Delta C_{t+1}, \pi_{t+1}) = \cdots \mathbb{cov}_t(-D_{t+1}/P_{t+1}, \pi_{t+1})$. Since this last term is positive and the covariance is proportional to minus the risk premium, debt contributes negatively to such a

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[21] We have used $\Delta \mathrm{c_t}$ instead of $\Delta C_{t+1}/C_t$ to maintain the same notation as in our initial derivations.

premium. If the agent were a creditor, the contribution would be positive, since D_{t+1} would be negative.

The motivation for assuming that the agent is a debtor comes from the conditions in the Eurozone. Consequently, in our representative agent model, we have considered nominal debt as exogenous, and in our empirical exercises, we ponder different types of debts.[22]

Intertemporal Risk

We next discuss the inter-temporal risk in our model. For the time being, suppose that the value of P_{t+1} is the same regardless of the state s, but still unknown in period t. This assumption cancels the risk across-states and, thus, allows us to focus on its intertemporal risk.

Assume that there is a deflationary environment. Accordingly, the net endowment next period ($W_{t+1} - D_{t+1}/P_{t+1}$) will diminish in real terms, leading to negative income effect. We thus have three key implications. First, expected consumption growth will decrease and, with it, the real interest rate (equation 2). Second, since the agent, in general, expects fewer resources next period, she will save more using the nominal bond, moving the nominal interest rate down (equation 3). Third, a higher expected deflation ($\mathbb{E}_t \pi_{t+1}$) directly implies a lower nominal interest rate (equation 5). Overall, the (in)deflation risk premium would have to decrease (equation 5).

Conversely, assume there is an inflationary environment. The net endowment will be greater next period ($W_{t+1} - D_{t+1}/P_{t+1}$), creating a positive income effect. There are then three key implications. First, expected consumption growth will increase and, thus, the real interest rate will rise (equation 2). Second, since in general the agent expects more resources next period,

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[22] Fleckenstein et al.'s (2013) logic is different from ours. They motivate the difference in the risk premium's sign based on the price level cyclicality or counter-cyclicality with output. In the former case, most of the output variation is due to aggregate demand shocks, leading to a positive covariance. In the latter, most of its variation is due to aggregate supply shocks, implying a negative covariance.

she will save less via the nominal bond, shifting the nominal rate upward (equation 3). Third, a higher expected inflation ($\mathbb{E}_t \pi_{t+1}$) leads to a higher nominal interest rate directly (equation 5). All in all, the (in)deflation risk premium should increase (equation 5).

In sum, based on intertemporal risk considerations, deflation leads to a lower risk premium and inflation to a higher one. If the representative agent were a creditor, the effects on the risk premium are ambiguous. For instance, in a deflationary environment, the real interest rate, the nominal interest rate, and expected deflation will increase. In this case, the overall effect on the risk premium depends on the relative magnitudes of the aforementioned changes (equation 5).

Risk Across-States

If there is a deflationary environment (i.e., it is more likely that $\pi_{t+1}(s) < \mathbb{E}_t(\pi_{t+1})$), in general, the agent will save more, but she will not be able to save enough for some states, for which $C_{t+1}(s) < \mathbb{E}_t(C_{t+1})$. As mentioned, markets are incomplete. Thus, the covariance term would tend to be positive. Moreover, deflation implies that the credit constraint is more likely to bind. Thus, the covariance's magnitude should be greater as the agent insures for less states (equation 1).

Next, consider the risk premium of the nominal bond $-\mathbb{cov}_t(i_t - \pi_{t+1}, -\beta\gamma\Delta c_{t+1})$. As said, the indicator of bad times is deflation. If deflation increases, then the real return of the nominal bond $i_t - \pi_{t+1}$ increases, and the stochastic discount factor $-\beta\gamma\Delta c_{t+1}$ rises, as expected consumption growth drops, leading to a negative risk premium. The agent has good reasons to buy the nominal bond, as it is favorable to her consumption-smoothing motive. Thus, in equilibrium, the risk premium would be small (or even negative).[23] Overall, deflation should contribute negatively toward the (de)inflation risk premium.

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[23] A more familiar example of this phenomenon is a car insurance. The car owner is willing to pay a premium above its actuarially fair price since the insurance will pay her in the state of nature when she needs resources the most, i.e., when a crash takes place. She buys insurance although, in expected value, the she will lose money. In effect, the insurance premium is not actuarially fair.

In contrast, if there is an inflationary environment (i.e., it is more likely that $\pi_{t+1}(s) > \mathbb{E}_t(\pi_{t+1})$), the agent will have more resources next period. Since she cannot borrow for some states of nature, we should have that $C_{t+1}(s) > \mathbb{E}_t(C_{t+1})$ for such states. Thus, the covariance term would tend to be positive. Moreover, in an inflationary environment, the credit constraint is less likely to bind. Accordingly, the covariance's magnitude will be smaller, as the agent is able to insure in more states.

Similarly, consider the risk premium of the nominal bond $-\mathbb{cov}_t(i_t - \pi_{t+1}, -\beta\gamma\Delta c_{t+1})$. The indicator of good times is inflation. If inflation increases, the real return of the bond $i_t - \pi_{t+1}$ decreases and the stochastic discount factor $-\beta\gamma\Delta c_{t+1}$ falls, as expected consumption growth increases, making the risk premium negative. Note, however, that while the nominal bond helps, it is not as favorable to her consumption-smoothing motive compared to the deflationary case. The agent then has fewer incentives to buy a nominal bond, leading in equilibrium to a premium that cannot be as small. In sum, inflation contributes negatively toward the risk premium, but not as much, relative to deflation.

Overall, based on risk across-states considerations, deflation, and inflation lead to a lower risk premium, and the magnitude of the effect should be more prominent in the case of deflation. Conversely, if the agent were a creditor, based on such considerations, both deflation and inflation would lead to a positive risk premium, as the real return of the nominal bond would co-move positively with consumption growth.

Prudence

The contribution of prudence toward the (in)deflation risk premium depends on the sign of $\mathbb{cov}_t((\Delta c_{t+1})^2, \pi_{t+1})$. We first note that it will not be as sizeable since the term $(\Delta c_{t+1})^2$ is in general smaller than consumption growth.[24] Based on our model, a higher deflation or

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[24] To see this, suppose that the covariance is positive and consider Stein's Lemma to obtain the following approximation:
$\mathbb{cov}_t((\Delta c_{t+1})^2, \pi_{t+1}) \approx \mathbb{E}_t(2\Delta c_{t+1})\mathbb{cov}_t(\Delta c_{t+1}, \pi_{t+1}) < \mathbb{cov}_t(\Delta c_{t+1}, \pi_{t+1})$ since $\mathbb{E}_t(2\Delta c_{t+1}) < 1$.

inflation leads to a greater consumption growth's second moment $(\Delta c_{t+1})^2$ as the agent cannot insure against all such changes, particularly so, in the case of deflation since the credit constraint is more likely to bind.

In this context, first, suppose there is a deflationary environment. Thus, the consumption growth's second moment $(\Delta c_{t+1})^2$ should increase, as the agent will be unable to insure for all states of nature. This would make the covariance term negative and thus have a negative contribution to the (in)deflation risk premium. This, all else being constant, should augment her precautionary savings. Second, suppose there is an inflationary episode. As inflation increases, then the consumption growth's second moment $(\Delta c_{t+1})^2$ would increase, leading to a positive covariance. We would nonetheless expect to observe a weaker effect, relative to a deflationary episode since the agent would be less likely to face a binding credit constraint.

Additionally, if the agent is more risk-averse, i.e., γ is larger, then the risk premium will increase in magnitude. Under a CRRA utility function the inter-temporal elasticity of substitution is equal to γ^{-1}. Thus, a lower intertemporal elasticity of substitution, i.e., the agent is less willing to substitute consumption across time, leads to a higher premium, since the agent will demand a greater compensation. For the same reason, if the agent is more prudent; i.e., $1 + \gamma$ is larger, then the risk premium will increase in magnitude. Consider that the agent's subjective discount factor affects the premium directly. The larger β is, the more the agent cares about her future consumption. Thus, given that changes in the price level distort her consumption path through time, the agent will demand a greater compensation to buy the bond.

To sum up, we have the following key implications, which we will explore in our empirical section below. First, in general, a higher debt should contribute negatively to the (in)deflation risk premium. Second, based on the inter-temporal risk, we have that deflation contributes negatively and inflation positively to the (in)deflation risk premium. Third, based on the risk across-states, both deflation and inflation contribute negatively toward the risk premium. Moreover, the contribution of deflation should be greater, as the agent values nominal bonds more highly and her credit constraint would more likely bind. Fourth, based on prudence, under deflation, its contribution should be negative and relatively greater, compared to that of inflation. Finally, the relative risk aversion, the inter-temporal elasticity of substitution, the prudence, the subjective discount coefficients affect the (in)deflation risk premium. Yet, their effects do not change through time.

3. Data and Statistics

We obtain consumption, inflation, and debt data for the following economies: Austria, Belgium, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, Switzerland, and the United Kingdom, for the 1Q-2001 to 2Q or 3Q-2014 period.

In the case of the Eurozone, inflation is measured based on the Harmonized Index of Consumption Prices (HICP). This index is widely known, frequently referred to, and extensively used. Thus, we use the HICP to measure changes in the price level in general.

Nonetheless, for the estimation of the risk premium, the consumption and inflation indices have to be associated with the same basket. Thus, to estimate the risk premiums, we use the inflation index that corresponds to the consumption index under consideration.

Relatedly, an agent obtains her utility from the services, the nondurables goods, and the portion of durables goods she consumes in a given period. Ideally, one should differentiate between the durables goods bought, which is what the data generally measure, and the portion of durables goods consumed in a given period.[25] Incorporating this explicitly would entail a separate model. Instead, we also estimate the risk premium with an index that excludes durable goods (i.e., index iv)).

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[25] For similar reasons, the income elasticity of demand for durable goods tends to be greater than that of nondurable goods.

In sum, we estimate risk premiums using the following four indices: [26]

i) Final consumption expenditure (FCE);[27]

ii) Final consumption expenditure of households, Total; (a subset of i)).

iii) Final consumption expenditure of households (HFCE); and, (a subset of ii))

iv) Final consumption expenditure of households, semi-durable goods, non-durable goods, and services (a subset of ii)).

In our first exercises, we estimate risk premiums using the i) index since it has the broadest coverage for the economies in our data set. However, in the case of the panel regressions, we only use indices ii), iii), and iv), mainly, for two reasons. First, they specifically measure household data, reflecting our representative agent model. Second, to maintain comparability across our panel regressions. In effect, although they have less coverage, they tend to include the same set of economies.[28]

We estimate consumption growth and inflation in year-over-year terms, which addresses seasonal effects. The frequency is quarterly. In this context, generally, the lower frequency of the consumption series used limit these exercises, since other time series are commonly available at higher frequencies. Accordingly, the setup of the models, associates our risk premium with a 1-year horizon.

The estimation of the (in)deflation risk premium entails the covariance of consumption growth and inflation, conditional on the information available in period t, e.g., $\mathbb{cov}_t(\Delta c_{t+1}, \pi_{t+1})$. To estimate it, we simply use the following expression:

$$\mathbb{cov}_t(\Delta c_{t+1}, \pi_{t+1}) = ((k+2)^{-1} \sum_{i=t-k}^{t+1} (\Delta c_i - \mathbb{E}\Delta c_t)(\pi_i - \mathbb{E}\pi_t)) \qquad (7)$$

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[26] The interested reader is referred to the European System of Accounts, ESA 2010 (page 70) for further details. The respective codes in the Eurostat database are P3, P31, P31_S14, and P312N.

[27] This final consumption expenditure index "consists of expenditure incurred by resident institutional units on goods or services that are used for the direct satisfaction of individual needs or wants or the collective needs of members of the community".

[28] HFCE essentially measures the same consumption basket as the HICP, except for the coverage of expenditure for housing by homeowners, thus, it is the closest to HICP. See URL1 and URL2 for further methodological details.

where $\mathbb{E}\Delta c_t = (k+2)^{-1}\sum_{j=t-k}^{t+1}\Delta c_j$, and $\mathbb{E}\pi_t = (k+2)^{-1}\sum_{j=t-k}^{t+1}\pi_j$. Specifically, we take $k = 2$, i.e., the last four observations, which is equivalent to a year. This captures, in a direct way, the most recent changes in their covariance.[29] We similarly estimate the term $\mathbb{COV}_t((\Delta c_{t+1})^2, \pi_{t+1})$.

As for the relative coefficients of risk aversion, we use estimates from Gandelman and Hernández-Murillo (2014). For those economies that are not in their paper, we take the average of the economies' coefficients common to their database and ours. As mentioned, the risk aversion coefficient has implications for the magnitude of the risk premium, but not for its dynamics.[30]

To assign a value to the subjective discount factor, we assume that the steady state real interest rate is 2.0% a year. Based on equation (2), we then have that $\beta = \exp(-0.02/4)$, which implies an approximate estimate for β of 0.99. The real interest rate is below the 3.0% used, e.g., in Schmitt-Grohé and Uribe (2006). Our lower value aims to account for the reduction in the level of real interest rate in recent years. Similarly, this factor affects the magnitude of the risk premium, but not its dynamics.[31]

We use three types of debts, external, government and domestic. They all refer to total debts. First, both residents and nonresidents can hold external debt, and residents owe it. Second, residents and non-residents can hold government debt, and the government owes it. Third, both residents and non-residents may hold domestic debt. As mentioned, to assess the

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[29] One could use an explicit model for consumption growth and inflation, e.g., a state-space model, and then estimate the covariance term based on it.

[30] We could have used greater relative coefficients of risk aversion as it sometimes done in the literature to account for the variability in the returns of assets. However, we are interested in documenting the asymmetry in the costs of deflation vs. inflation, rather than their absolute magnitudes.

[31] In a representative agent model, one can consider consumption growth per capita. Thus, accounting for population growth is potentially relevant. In our case, a drawback of using population data is that they are not available at a quarterly frequency for some economies in our database. Thus, we use as a working assumption that population growth is constant and equal to zero. This is trivial assumption at a low frequency (see, e.g., Juselius and Takáts, 2015); however, the period covered in our estimation does not surpass 15 years, and entails quarterly data.

possible effects due to changes in the price level, such a distinction is important. We use each type, in turn, as an empirical counterpart to the debt term in the model. Debt levels with respect to their GDP are for the most part sizeable (Tables 3-5).

Their starting period for each series depends on the series and the economy in question. However, for our exercises, we have used a common starting point, the first quarter of 2001. The ending quarters of the time series depend on the specific economy. We do this in order to have, as much as possible, a balanced panel data set. Some economies lack some time series, and, thus, we have excluded them from the respective panel regression.[32] We indicate these economies by a dash in the respective tables (Tables 3, 4 and 5).

We next consider their main statistics. First, except for Denmark, Iceland, and the United Kingdom, all economies in our database have had periods with deflation (last column of Table 1).[33] Second, the (in)deflation risk premiums can be both positive and negative, reflecting their time-varying nature. Moreover, all economies in our data set have experienced negative values (last column, Table 2). This is quite plausible, as a reflection of deflationary risk.

On a related matter, note that Greece, Ireland, Portugal, and Spain present an average negative premium. An interpretation of this finding is their potential need then of real exchange depreciations through deflation, given the lack of individual exchange rate policies. In effect, all four economies belong to the Eurozone.

We have some further comments on the statistics of (in)deflation. To that end, consider a(n) in(deflation) data point $\pi_{i,t}$, which we associate with an economy i and a quarter t in our database. First, we have that 91 data points (out of 2,186) have presented deflation, accounting for 4.2% of the total. Second, on average, an economy has had 3.4 periods (out of an average of 55.3 periods) with deflation. In other words, on average, an economy has

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[32] Bulgaria and Romania are dropped altogether from the analysis as their risk premiums are unconceivable large, suggesting that the associated series are possibly not stationary.

[33] By deflation, we mean a negative percentage change in the price level year-over-year.

seen deflation 6% of the time. The standard deviation of this last statistic is 7%. Third, a given economy may as well have had a positive probability of a deflation period without actually experimenting one.

		Mean	Std.	Max	Min
Austria		2.05	0.89	4.05	-0.31
Belgium		2.06	1.26	5.75	-1.04
Croatia	+	2.69	1.49	7.30	-0.07
Cyprus		2.24	1.57	6.35	-1.25
Czech Republic		2.30	1.74	7.14	-0.62
Denmark		1.83	0.95	4.54	0.17
Estonia		4.02	2.81	11.47	-1.87
Finland	+	1.93	1.09	4.72	-0.44
France		1.79	0.85	3.98	-0.57
Germany		1.68	0.79	3.37	-0.46
Greece		2.63	1.84	5.66	-1.82
Hungary		4.85	2.34	10.46	-0.52
Iceland	+	5.64	4.84	21.03	0.35
Ireland	+	1.91	2.01	5.08	-3.01
Italy		2.22	0.97	4.01	-0.08
Luxembourg	+	2.56	1.31	5.34	-0.98
Malta		2.32	1.28	4.98	-0.58
Netherlands		2.13	1.26	5.30	-0.03
Poland		2.65	1.60	6.18	-0.24
Portugal	+	2.28	1.58	5.13	-1.80
Slovakia		3.62	2.59	9.37	-0.16
Slovenia	+	3.58	2.39	9.67	-0.10
Spain		2.58	1.40	5.06	-0.95
Sweden		1.59	0.97	4.18	-0.35
Switzerland		0.42	1.01	2.84	-1.24
United Kingdom		2.33	1.07	5.25	0.63
Average		2.53	1.61	6.47	-0.67

Table 1. Inflation Statistics (HICP). Notes: Year over Year percentage growth of quarterly observations. Sample periods: 1Q-2001 to 2Q-2014 (marked by +) or 3Q-2014 (unmarked). **Source**: Own calculations with data from Eurostat.

		Mean	Std.	Max	Min
Austria		0.10	0.22	0.68	-0.76
Belgium		-0.04	0.46	0.71	-2.26
Croatia	+	0.04	0.39	1.04	-1.76
Cyprus		-0.84	1.99	1.37	-10.05
Czech Republic		0.30	0.79	3.48	-0.67
Denmark		0.05	0.22	0.96	-0.47
Estonia		-0.50	2.15	1.74	-9.27
Finland	+	0.01	0.30	1.03	-1.31
France		0.04	0.23	0.83	-0.53
Germany		0.00	0.09	0.37	-0.19
Greece		-0.56	2.31	3.05	-9.84
Hungary		0.43	1.78	6.42	-3.28
Iceland	+	4.54	8.08	42.83	-0.61
Ireland	+	-0.12	0.58	0.47	-2.54
Italy		0.03	0.24	0.75	-0.75
Luxembourg	+	0.16	0.63	2.99	-1.20
Malta		0.99	1.46	5.26	-1.66
Netherlands		0.00	0.02	0.05	-0.05
Poland		-0.01	0.22	0.53	-0.59
Portugal	+	-0.15	0.82	1.87	-2.79
Slovakia		0.72	1.88	10.85	-2.89
Slovenia	+	-0.09	0.57	0.99	-2.79
Spain		-0.10	0.61	0.87	-2.73
Sweden		0.20	0.28	1.08	-0.30
Switzerland		0.17	0.24	0.96	-0.37
United Kingdom		0.01	0.35	0.91	-1.19
Average		0.21	1.04	3.54	-2.34

Table 2. (In)Deflation Risk Premium Statistics. Notes: Basis points of quarterly estimates of the risk premium, including the prudence premium. Sample periods are 1Q-2001 to 1Q-2014 (marked by +) or 2Q-2014 (unmarked). **Sources:** Own estimations with data from Eurostat, and Gandelman and Hernández-Murillo (2014).

	Mean	Std. D.	Max	Min
Austria	-	-	-	-
Belgium	120.63	8.87	136.88	101.05
Croatia	42.26	15.92	77.86	28.16
Cyprus	-	-	-	-
Czech Republic	25.97	9.82	42.46	11.08
Denmark	62.58	8.93	72.48	40.02
Estonia	3.34	1.76	7.33	1.02
Finland	53.34	8.82	71.74	36.02
France	92.25	14.85	123.61	73.64
Germany	71.23	8.75	86.73	57.39
Greece	135.59	22.49	192.32	112.73
Hungary	68.21	7.46	78.25	55.23
Iceland	-	-	-	-
Ireland	58.83	35.89	122.71	24.81
Italy	111.15	11.01	144.11	97.33
Luxembourg	12.24	7.05	27.67	5.60
Malta	66.23	4.22	75.44	57.39
Netherlands	61.83	9.48	79.36	47.31
Norway	48.60	8.08	61.14	32.51
Poland +	44.45	3.60	50.47	35.06
Portugal	80.82	27.97	139.23	48.37
Slovakia	37.80	8.68	54.95	23.30
Slovenia	31.24	13.21	68.06	18.64
Spain	71.63	26.81	141.01	43.95
Sweden	51.27	6.67	65.21	41.01
Switzerland	21.38	3.44	26.12	16.79
United Kingdom	60.23	23.73	100.76	38.32
Average	59.71	12.40	85.25	43.61

Table 3. Total Government Debt as a percentage of GDP, Statistics.

Notes: Sample periods: 1Q-2001 to 2Q-2014 (marked by +) or 3Q-2014 (unmarked).

Source: Haver Analytics.

	Mean	Std. D.	Max	Min
Austria	-	-	-	-
Belgium	418.91	48.61	494.79	360.77
Croatia	-	-	-	-
Cyprus	-	-	-	-
Czech Republic	242.93	1.27	244.74	241.25
Denmark	521.72	86.56	627.80	384.19
Estonia	-	-	-	-
Finland	275.74	39.95	336.43	225.25
France	395.11	54.25	476.42	326.79
Germany	327.04	12.73	358.05	296.65
Greece	260.51	57.91	385.72	188.84
Hungary	271.65	54.33	338.95	187.73
Iceland	-	-	-	-
Ireland	1,683.27	572.81	2,347.57	719.99
Italy	335.21	42.06	399.13	273.72
Luxembourg +	2,786.48	1,101.57	4,871.34	1,489.88
Malta	-	-	-	-
Netherlands	801.47	13.68	820.63	780.01
Norway	368.32	39.21	443.62	299.91
Poland +	179.01	23.03	212.76	146.49
Portugal	333.15	66.20	430.74	234.88
Slovakia	199.27	5.27	205.99	191.22
Slovenia	292.84	4.61	299.48	285.86
Spain	384.15	78.71	484.13	257.96
Sweden	409.21	51.31	482.29	341.82
Switzerland	-	-	-	-
United Kingdom	444.14	70.83	541.06	335.00
Average	546.51	121.25	740.08	378.41

Table 4. Total Domestic Debt as percentage of GDP, Statistics.

Notes: Sample periods: 1Q-2001 to 2Q-2014 (marked by +) or 3Q-2014 (unmarked).

Source: Haver Analytics.

	Mean	Std. D.	Max	Min
Austria	177.61	26.66	211.89	128.22
Belgium	266.75	33.48	349.46	204.42
Croatia	81.28	20.84	109.77	48.05
Cyprus	522.92	95.20	784.07	350.93
Czech Republic	43.14	12.28	64.39	28.11
Denmark	168.05	16.75	191.26	134.85
Estonia	89.61	23.49	132.12	49.30
Finland	142.37	47.12	235.72	93.80
France	189.35	10.19	203.78	165.88
Germany	140.10	14.59	167.68	111.69
Greece	160.38	48.90	234.14	87.70
Hungary	100.58	33.72	149.48	52.34
Iceland	500.26	312.34	982.48	102.26
Ireland	815.50	235.65	1,121.80	375.02
Italy	105.69	13.40	123.09	78.89
Luxembourg	3,897.52	955.66	5,745.15	2,698.82
Malta	762.57	371.73	1,143.63	226.13
Netherlands	505.93	16.07	530.42	470.97
Norway	129.63	21.30	173.28	91.71
Poland	53.33	11.75	72.40	35.93
Portugal	193.58	33.42	238.22	128.24
Slovakia	62.10	13.85	88.87	41.52
Slovenia	85.56	29.18	124.67	39.69
Spain	134.97	28.97	168.32	81.64
Sweden	175.39	23.25	204.73	122.96
Switzerland	220.06	23.22	284.33	185.13
United Kingdom	322.34	57.06	414.76	232.78
Average	372.10	93.71	527.77	235.81

Table 5. Total Gross External Debt as percentage of GDP, Statistics.

Notes: Sample periods: 1Q-2001 to 3Q-2014.

Source: Haver Analytics

4. Panel Data Regression Models and Estimations

We next explore the extent to which key exogenous variables in our model are priced in by the estimated risk premiums. A particular feature we want to explore is the extent to which the pricing implications of inflation and deflation differ. Accordingly, we estimate the following data panel regressions.

$$\begin{aligned}
RP_{i,t} &= \alpha_0 + \alpha_\pi \pi_{i,t} && + \alpha_{\mathrm{d},\cdot}\, \Delta d_{i,t} && + e_{i,t} \quad \text{(Models 1-3)}\\
RP_{i,t} &= \beta_0 + \beta_{\pi+}\pi_{i,t}^{+} + \beta_{\pi-}\pi_{i,t}^{-} && + \beta_{\mathrm{d},\cdot}\, \Delta d_{i,t} && + \epsilon_{i,t} \quad \text{(Models 4-6)}\\
RP_{i,t} &= \gamma_0 + \gamma_{\pi+}\pi_{i,t}^{+} + \gamma_{\pi-}\pi_{i,t}^{-} && + \gamma_{\mathrm{d}\cdot,+}\Delta d_{i,t} I_{i,t}^{+} + \gamma_{\mathrm{d}\cdot,-}\Delta d_{i,t} I_{i,t}^{-} && + \varepsilon_{i,t} \quad \text{(Models 7-9)}
\end{aligned}$$

where $RP_{i,t}$ is the (in)deflation risk premium, i.e., the estimate of $-\beta\gamma\mathbb{cov}_t(\Delta c_{t+1}, \mathrm{\pi_{t+1}}) + \beta\gamma\rho\mathbb{cov}_t((\Delta c_{t+1})^2, \mathrm{\pi_{t+1}})/2$, of economy i in quarter t, $\pi_{i,t} = (P_{i,t}/P_{i,t-1} - 1)$ is the inflation rate of economy i in quarter t, $\Delta d_{i,t}$ is the percentage change of debt over GDP, $\pi_{i,t}^{+} = \max\{\pi_{i,t}, 0\}$, $\pi_{i,t}^{-} = \min\{\pi_{i,t}, 0\}$. In addition, $I_{i,t}^{+} = 1\{\pi_{i,t} > 0\}$ is an indicator function which equals one if inflation is positive and zero in other cases, $I_{i,t}^{-} = 1\{\pi_{i,t} \leq 0\}$ is an indicator function which equals one if inflation is negative and zero in other cases, and $e_{i,t}$, $\epsilon_{i,t}$ and $\varepsilon_{i,t}$ are error terms for which we have assumed fixed effects. Accordingly, we have the associated coefficients α, β and γ, noting that their sub-indices indicate the variable they relate to.

We have thus constructed variables to capture explicitly the effects that inflation and deflation could have directly and as they interact with debt. For instance, $\Delta d_{i,t} I_{i,t}^{-}$ considers the effect of debt growth under deflation and $\Delta d_{i,t} I_{i,t}^{+}$ the effect of debt growth under inflation. We ponder debt over GDP to capture an economy's capacity to back its debt.

We note that the equation numbers by line depend on the type of debt we consider. Thus, Models 1, 4, and 6 use external debt, Models 2,5, and 8 use domestic debt, and Models 3, 6, and 9 use government debt.

In addition, we estimate the following panel regression to explore briefly the impact of deflation and inflation on the prudence premium $\beta\gamma\rho\mathbb{cov}_t((\Delta c_{t+1})^2, \pi_{t+1})/2$.

$$PP_{i,t} = \delta_0 + \delta_1\pi_{i,t}^{+} + \delta_2\pi_{i,t}^{-} + u_{i,t} \qquad \text{(Model 10)}$$

where $PP_{i,t}$ is the prudence premium. As above, the table's number (i.e., 6, 7 or 8) depend on the type of price and consumption indices we have used.

The following comments are in order. We use fixed effects to account for the different degrees of financial development across the economies, with other possible unobserved heterogeneity. Our implicit assumption is that their financial development has been constant in the sample period. Still, we cannot use the financial development indices directly in the regressions because they are only available at a yearly frequency and for a limited number of years.

4.1. Preliminaries

As a prelude to the panel data regressions' estimates, we document the following two relationships.[34]

i) A negative correlation between the time series of the aggregated inflation risk premium, and a systemic stress index (CISS) in the financial system. We built this risk premium based on the (FCE) consumption and inflation series of EU-28.
ii) A negative correlation between the absolute value of the (time-averaged) economies' risk premium and their respective financial development indices.

On the first relation, we have the following comments. First, periods during which the risk premium is negative are associated with increments in the systemic stress index. On the other hand, periods during which the risk premium is positive, such an index tends to diminish

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[34] For reasons explained in the main text, for these estimations we have used the FCE index.

(Figure 1). When regressing the risk premium on the systemic stress index, we obtain a statistically significant coefficient and a value for R^2 of 0.32.

In our model, more inflation might unbind the credit constraint of the agent, allowing her securing her consumption in more states of nature. This would imply a smoother consumption growth and, thus, a premium with a smaller magnitude. In contrast, greater deflation might make the credit restriction bind, constraining her consumption growth in more states of nature, increasing her consumption variability and, hence, making the premium's magnitude greater. This is consistent with the empirical feature that its magnitude tends to be greater during deflation episodes than during inflation ones (Figure 1). The plot allows us to appreciate that this result is driven by the second part of the sample period; for the most part, during the European Debt Crisis and its aftermath.

Second, the economies considered are restricted to those for which their individual Financial Development Index 2014 (WEF) is available, namely: Austria, Belgium, the Czech Republic, Denmark, Finland, Germany, Greece, Hungary, Ireland, Italy, the Netherlands, Poland, Portugal, Sweden, and Switzerland. We thus plot the absolute value each country's time averaged risk premium time series (sample period 1Q 2000-1Q 2014/2Q 2014) along with their financial development indices from 2014 (Figure 2)[35]. They have an R^2 of 0.35. However, if the two data points at the top (the Czech Republic and Hungary) are excluded from this estimation, the R^2 decreases to 0.2.

Of course, the (in)deflation risk premium depends on several other factors. Nonetheless, these relations are suggestive of the role played by the level of financial development in determining the magnitude of the (in)deflation risk premium. This is consistent with our model to the extent to which the number of Arrow-Debreu securities (with respect to the total number of states) and the actuarially fair pricing assumption capture the level of financial development.

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[35] The year has been chosen to coincide with the last year of our database.

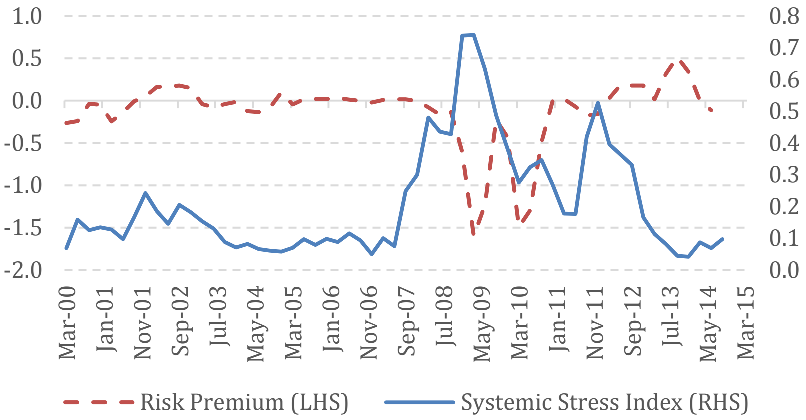

Figure 1. Inflation Risk Premium for EU-28, and Systemic Stress Composite Indicator in the Financial System (CISS). Notes: Basis Points and Index. **Sources**: Own estimations with data from Eurostat, and Gandelman and Hernández-Murillo (2014), and CISS, Systemic Stress Composite Indicator (Holló, Kremer, and Duca, 2012).

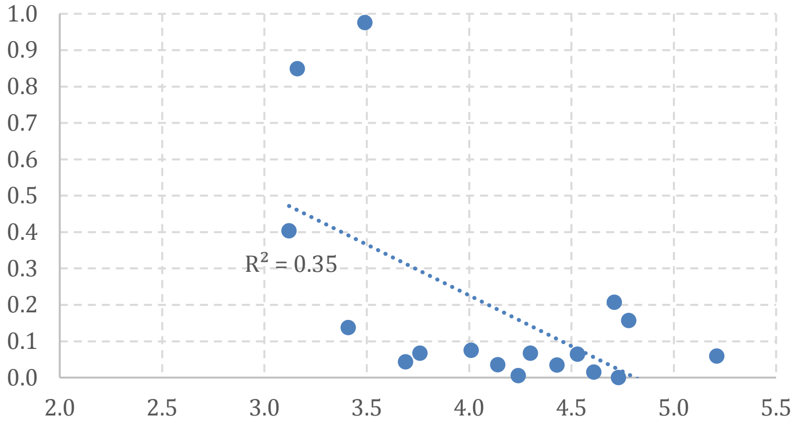

Figure 2. Absolute Values of the (Time Averaged) Risk Premiums and Financial Development Indices for a set of Economies.

Notes: the variables are y-axis and x-axis, respectively.

Sources: Own estimations with data from Eurostat, and Gandelman and Hernández-Murillo (2014). The Financial Index is the WEF Financial Development Index (2014).

4.2. Panel Data Regression Estimations

We next present our results for the panel data regressions.[36] In each regression, we vary the type of debt that is included as part of the explanatory variables, as well as the consumption and price series with which the (in)deflation risk premium is constructed. In effect, we vary the type of debt within the same table, and we vary the types of consumption and price series across tables.

As mentioned, the equation numbers by line depend on the type of debt we consider. Thus, Models 1, 4, and 6 use external debt, Models 2, 5, and 8 use domestic debt, and Models 3, 6, and 9 use government debt. In addition, we note that the table's number depend on the type of price and consumption indices we have used.

Similarly, we vary the indices: ii) final consumption expenditure of households, total; iii) final consumption expenditure of households; and, iv) final consumption expenditure of households of semi-durable goods, non-durable goods, and services, and their price indices, to construct the respective risk premiums. Thus, Models 1-3 use index ii), Models 4-6 use index iii) and Models 7-9 use index iv), as indicated.

We limit our panel data estimation to the following economies: Austria, Belgium, Cyprus, Estonia, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Malta, the Netherlands, Portugal, Slovakia, Slovenia, and Spain. All these economies are part of the Eurozone.[37] As mentioned, this is because the bulk of their debts are denominated in euros.[38]

On our estimations, we have the following remarks based on the key implications of our model. First, one of the model's central implication is that debt by contributes negatively

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[36] A comment about measurement errors is appropriate. As is known, measurement error leads to bias in the estimated coefficients; i.e., the so-called attenuation bias. Of course, macroeconomic variables have measurement errors. The fact that our relevant coefficients are statistically significant is reassuring.

[37] We do not include Latvia and Lithuania, which have just recently joined the Eurozone in 2014 and 2015, respectively.

[38] See, e.g., www.ecb.europa.eu.

toward the risk premium. Models 1-6 in Tables 6-8 are in line with such a result. In effect, out of the 18 relevant regressions, all coefficients are negative and eight are statistically significant.

Second, a key implication of our model is the contribution of inflation on the risk premium. Models 1-3 in Tables 6-8 explore its general role, that is, without distinguishing whether it is in inflation or deflation. In all cases, coefficients are statistically significant. We have that a higher (lower) inflation leads to a higher (lower) risk premium. This is in line with the role of intertemporal risk under the presence of inflation.

Third, we explore the contribution of inflation, but now differentiating between the effect inflation (i.e., when positive) and deflation have on the risk premium. Models 4-9 in Table 6-8 feature such a differentiation. We note that out of the 36 relevant coefficients (i.e., 18 panel regressions), we have that except for one case they all have positive signs. From those, 28 are statistically significant. In effect, deflation contributes negatively toward the risk premium in line with the intertemporal risk and risk across-states implications we have explained before. Inflation contributes positively, underling that the intertemporal risk dominates the risk across-states in such a case. What is more, we underscore the difference in magnitude of those coefficients associated with deflation vis-à-vis those associated with inflation. The magnitudes of the deflation's coefficients are greater compared to those associated with inflation in essentially all the cases in which the coefficients are statistically significant.

Fourth, we explore the contribution of debt under deflation and, separately, under inflation (Models 7-8). As described above, to that end, we have constructed a variable, which equals debt growth times a dummy variable that is one under deflation and zero otherwise. Similarly, we have constructed a variable, which equals debt growth times a dummy variable that is one under inflation and zero in other cases. Their associated coefficients tend to be negative and statistically significant in the case of deflation. In two cases, the debt-inflation terms are positive and statistically significant (Model 8 in Tables 6 and 8). One plausible interpretation of their negative contribution is that risk across-states dominates the intertemporal risk in this case. At any rate, in both cases their contributions are small in comparison to those associated with deflation.

Finally, we regress the component of the risk premium associated with the prudence coefficient on deflation and inflation. We note that such a component is part of the risk premium, as described above. Our prior is that deflation's contribution should be negative. We underline that out of three coefficients associated with deflation. We have that all three coefficients are statistically significant and positive, in effect, leading to a negative contribution. Conversely, one of the coefficients associated with inflation is statistically significant. Similarly, its magnitude is smaller, compared to those related to deflation (Model 10 in Tables 6-8).

5. Final Remarks

We have presented evidence that suggests that deflation, under the presence of debt, might entail economic costs. The presence of incomplete markets, in particular, credit constraints, rationalize such costs. Importantly, they point toward deflation being relatively more costly than inflation. Evidently, as mentioned, other factors may very well have a role in the determination of its costs.

More generally, we think that one should be concerned about the conditions under which deflation might bring about economic costs. In our simple model, changes in the price level distort income intertemporally and across states of nature and, in tandem, affect the (in)deflation risk compensation for a nominal bond holder. A more developed financial system seems to mitigate such costs.

Second, a strand of the literature has assessed the costs of (in)deflation in terms of its relationship to output. On a related topic, the literature measuring the cost of business cycles has focused on doing so in terms of consumption growth, directly, as in, e.g., Lucas (1991), or indirectly, as in, e.g., Alvarez and Jermann (2004).[39] Similarly, we think that the assessment of deflation costs could also explore its impact in terms of consumption, measured directly or indirectly, as we have done.[40] Naturally, this approach comes with its challenges and data requirements.

Third, in the periods and in the economies we have considered, deflation episodes have been relatively brief, as we have documented. Thus, econometrically, one cannot quantify its potential costs very robustly. Moreover, as we have underscored, a given economy might face the probability of a deflation episode, possibly reflected by a negative risk premium, without actually having undergone one.

Fourth, from a historical perspective as financial markets have evolved, one could argue that the potential costs of deflation have generally diminished. This is not to say, however, that one can ignore the possibility of such costs surging, for instance, once a dislocation in financial markets takes place, as the Great Financial Crisis and the European debt crisis have shown us.

Fifth, traditional consumption-based asset pricing models are generally not as popular in empirical work.[41] For example, Hansen and Singleton (1983) have documented some of their limitations. One of them is their asset excess returns' implied magnitudes. Nonetheless, our focus has been on the costs of deflation relative to inflation. We could have also used, for instance, a more general utility function.[42] We leave such analyses for future research.

Finally, central bankers seem to dislike deflation particularly and, in many of the economies we have considered, they have made significant efforts to avoid a deflationary scenario. We think that their distaste for deflation is well founded.

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[39] Alvarez and Jermann (2004) use asset prices to measure the costs of business cycles.
[40] In fact, in the derivation of some monetary models, one substitutes consumption for output.
[41] By traditional, we mean consumption models that use utility functions that are time-separable.
[42] One could consider, for example, the use of an Epstein and Zin (1989) utility functions.

		Model 1 RP	Model 2 RP	Model 3 RP	Model 4 RP	Model 5 RP	Model 6 RP	Model 7 RP	Model 8 RP	Model 9 RP	Model 10 PP
Inflation	α_{π}	22.91***	26.48***	22.83***							
		(3.386)	(4.623)	(3.302)							
External Debt	$\alpha_{\Delta de}$	-1.390			-1.387						
		(0.917)			(0.918)						
Domestic Debt	$\alpha_{\Delta dd}$		-3.034**			-3.029**					
			(1.530)			(1.531)					
Gvt. Debt	$\alpha_{\Delta dg}$			-0.368			-0.360				
				(0.765)			(0.766)				
Inflation+	$\alpha_{\pi+}$				0.233***	0.279***	0.224***	0.232***	0.278***	0.215***	-0.00249
					(0.0375)	(0.0556)	(0.0361)	(0.0377)	(0.0555)	(0.0361)	(0.00260)
Inflation-	$\alpha_{\pi-}$				0.154	0.118	0.312	0.150	0.0638	-0.130	0.0641***
					(0.289)	(0.313)	(0.302)	(0.289)	(0.314)	(0.340)	(0.0211)
External D. × I+	$\alpha_{de,+}$							-1.337			
								(0.925)			
External D. × I-	$\alpha_{de,-}$							-4.504			
								(6.882)			
Domestic D. × I+	$\alpha_{dd,+}$								-2.576*		
									(1.552)		
Domestic D. × I-	$\alpha_{dd,-}$								-17.31**		
									(8.708)		
Gvt. D. × I+	$\alpha_{dg,+}$									0.00253	
										(0.773)	
Gvt. D. × I-	$\alpha_{dg,-}$									-11.64***	
										(4.137)	
Constant	α_{0}	-23.43***	-26.93***	-23.27***	-0.531***	-0.493***	-0.419***	-0.526***	-0.492***	-0.393***	-0.0120
		(3.471)	(4.726)	(3.390)	(0.116)	(0.143)	(0.114)	(0.117)	(0.143)	(0.114)	(0.00794)
T		656	445	687	656	445	687	656	445	687	794
R^2		0.07	0.08	0.07	0.07	0.08	0.07	0.07	0.08	0.08	0.01
N		15	11	13	15	11	13	15	11	13	15

Table 6. Panel Regression Estimates. Notes: We have used indices ii) Final consumption expenditure of households, Total**.** Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1 Sample periods: 1Q-2001 to 3Q-2014 or 4Q-2014, depending on the economy. Debt growth rates are estimated based on their ratios over GDP. **Sources:** Own estimations with data from Eurostat, Gandelman and Hernández-Murillo (2014) and Haver Analytics.

		Model 1 RP	**Model 2 RP**	**Model 3 RP**	**Model 4 RP**	**Model 5 RP**	**Model 6 RP**	**Model 7 RP**	**Model 8 RP**	**Model 9 RP**	**Model 10 PP**
Inflation	β_{π}	28.32***	24.56***	26.11***							
		(3.302)	(3.648)	(3.064)							
External Debt	$\beta_{\Delta de}$	-1.303			-1.312						
		(0.921)			(0.922)						
Domestic Debt	$\beta_{\Delta dd}$		-2.478*			-2.466*					
			(1.277)			(1.277)					
Gvt. Debt	$\beta_{\Delta dg}$			-1.288*			-1.237*				
				(0.722)			(0.722)				
Inflation+	$\beta_{\pi +}$				0.268***	0.215***	0.241***	0.264***	0.213***	0.229***	-0.00239
					(0.0371)	(0.0449)	(0.0340)	(0.0372)	(0.0448)	(0.0338)	(0.00285)
Inflation-	$\beta_{\pi -}$				0.467**	0.444**	0.535***	0.458**	0.389**	0.0864	0.0706***
					(0.207)	(0.176)	(0.200)	(0.207)	(0.178)	(0.229)	(0.0169)
External D. × I+	$\beta_{de,+}$							-1.159			
								(0.929)			
External D. × I-	$\beta_{de,-}$							-9.572			
								(6.500)			
Domestic D. × I+	$\beta_{dd,+}$								-2.034		
									(1.298)		
Domestic D. × I-	$\beta_{dd,-}$								-13.59**		
									(6.477)		
Gvt. D. × I+	$\beta_{dg,+}$									-0.691	
										(0.729)	
Gvt. D. × I-	$\beta_{dg,-}$									-14.42***	
										(3.440)	
Constant	β_0	-29.02***	-25.10***	-26.68***	-0.646***	-0.455***	-0.500***	-0.635***	-0.453***	-0.467***	-0.00935
		(3.383)	(3.726)	(3.143)	(0.112)	(0.115)	(0.105)	(0.112)	(0.115)	(0.104)	(0.00855)
T		742	550	792	742	550	792	742	550	792	904
R^2		0.1	0.08	0.09	0.09	0.08	0.1	0.1	0.09	0.11	0.020
N		17	13	15	17	13	15	17	13	15	17

Table 7. Panel Regression Estimates. Notes: We have used indices iii) Final consumption expenditure of households**.** Standard errors in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$ Sample periods: 1Q-2001 to 3Q-2014 or 4Q-2014, depending on the economy. Debt growth rates are estimated based on their ratios over GDP. **Sources:** Own estimations with data from Eurostat, Gandelman and Hernández-Murillo (2014) and Haver Analytics.

		Model 1 **RP**	**Model 2** **RP**	**Model 3** **RP**	**Model 4** **RP**	**Model 5** **RP**	**Model 6** **RP**	**Model 7** **RP**	**Model 8** **RP**	**Model 9** **RP**	**Model 10** **PP**
Inflation	γ_{π}	20.60***	18.43***	21.38***							
		(2.956)	(3.668)	(2.990)							
External Debt	$\gamma_{\Delta de}$	-0.777			-0.780						
		(0.774)			(0.774)						
Domestic Debt	$\gamma_{\Delta dd}$		-2.265**			-2.138**					
			(1.095)			(1.078)					
Gvt. Debt	$\gamma_{\Delta dg}$			0.778			0.865				
				(0.674)			(0.675)				
Inflation+	$\gamma_{\pi+}$				0.193***	0.107**	0.191***	0.192***	0.0903**	0.186***	-0.005**
					(0.0322)	(0.0417)	(0.0320)	(0.0324)	(0.0418)	(0.0320)	(0.00213)
Inflation-	$\gamma_{\pi-}$				0.489*	1.212***	0.821***	0.487*	0.926***	0.387	0.0836***
					(0.283)	(0.281)	(0.315)	(0.283)	(0.297)	(0.376)	(0.0198)
External D. × I+	$\gamma_{de,+}$							-0.750			
								(0.780)			
External D. × I-	$\gamma_{de,-}$							-2.680			
								(5.888)			
Domestic D. × I+	$\gamma_{dd,+}$								-1.871*		
									(1.073)		
Domestic D. × I-	$\gamma_{dd,-}$								-33.63***		
									(11.39)		
Gvt. D. × I+	$\gamma_{dg,+}$									1.102	
										(0.682)	
Gvt. D. × I-	$\gamma_{dg,-}$									-7.067*	
										(3.828)	
Constant	γ_0	21.06***	-18.77***	-21.79***	-0.416***	-0.140	-0.335***	-0.412***	-0.0971	-0.321***	-0.00573
		(3.032)	(3.747)	(3.069)	(0.0992)	(0.103)	(0.100)	(0.0999)	(0.103)	(0.100)	(0.00646)
T		614	394	636	614	394	636	614	394	636	743
R^2		0.08	0.07	0.08	0.08	0.10	0.08	0.08	0.12	0.09	0.026
N		14	10	12	14	10	12	14	10	12	14

Table 8. Panel Regression Estimates. Notes: We have used indices iv) Final consumption expenditure of households, semi-durable goods, non-durable goods, and services. Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1 Sample periods: 1Q-2001 to 3Q-2014 or 4Q-2014, depending on the economy. Debt growth rates are estimated based on their ratios over GDP. Sources: Own estimations with data from Eurostat, Gandelman and Hernández-Murillo (2014) and Haver Analytics.

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Appendix

Eurostat Abbreviations.

EU-15: Belgium, Denmark, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, UK, Austria, Finland, and Sweden.

EU-27: EU-15 + Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovakia, and Slovenia + Bulgaria + Romania.

EU-28: EU-27 + Croatia.