Inflation, nominal portfolios, and wealth redistribution in Canada

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Abstract. This paper quantifies the redistributional effects of inflation in Canada that arise through the revaluation of nominal assets and liabilities. We find that the effects are non-trivial even for low inflation episodes. The main winners are young, middle-class households with mortgage debt. The government receives a windfall gain from its long-term debt. The old, the rich or the middle-aged, middle-class lose, largely owing to their holdings of bonds and non-indexed defined benefit pension assets. Finally, our Canada-U.S. comparison reveals that the extent of redistributions can be quite different even between countries of similar economic and legal environments. JEL classification: D31, E31

Inflation, portefeuilles nominaux, et redistribution de la richesse au Canada. Ce texte quantifie les effets de redistribution de la richesse de l'inflation au Canada attribuable à la réévaluation des actifs et des dettes nominaux. On découvre que ces effets ne sont pas insignifiants même pour des épisodes de faible inflation. Le gouvernement encaisse un gain inattendu de sa dette à long terme. Les plus vieux, les riches ou la classe moyenne d'âge moyen essuient des pertes à cause des obligations qu'ils détiennent et des actifs non-indexés dans leurs régimes de rentes à prestations définies. Finalement, les comparaisons Canada-États-Unis montrent que l'importance de la redistribution peut être fort différente même entre deux pays où les environnements économiques et légaux se ressemblent.

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1. Introduction

One of the most important arguments in favour of price stability is that inflation generates arbitrary changes in the distribution of income and wealth among different economic agents. These redistributions occur because many loans in the economy are specified in fixed dollar terms. Unanticipated inflation redistributes wealth from creditors to debtors by lowering the real value of nominal assets and liabilities. In this paper, we quantify the redistributional effects of inflation that arise through the revaluation of nominal claims. We estimate the extent of the inflation-induced redistribution of wealth by conducting a data-based simulation in which Canadians experience various inflation episodes. We ask how the distribution of wealth among economic agents would change and find that the redistributional effects of inflation are non-trivial.

One motivation for measuring the redistributional effects of inflation is the current public debates in several countries about potential refinements to their monetary policy regimes. For example, since the arrival of Chairman Bernanke at the Federal Reserve Bank, discussion has intensified as to whether the U.S. should adopt an inflation-targeting regime. In Canada, where the inflation-targeting experience has been successful, a systematic review of the monetary policy regime is underway in preparation for a potential reform in 2011.[1] The review considers two broad sets of questions.[2] The first is about the potential costs and benefits of lowering the inflation target rate below 2%, and the second concerns the potential costs and benefits of replacing the inflation-targeting framework with an alternative regime such as price-level targeting.[3] In evaluating this potential monetary policy reform, it is important to account for the redistributional effects of inflation, since the welfare implications of any monetary policy regime depend not only on aggregate effects but also on redistributional consequences. A sense of who would win and who would lose is essential in order to assess transitional costs and potential support for reform. As the baby boom generation is quickly aging, the number of retirees with fixed nominal income and nominal assets (including many pensions) is rapidly increasing, and, therefore, popular support is growing for any reform that reduces fluctuations in nominal income and wealth. For these reasons, it is important to evaluate the potential redistributional effects of inflation and this is what we do in this paper.

In doing so we make three contributions to the literature on portfolios and inflation. First, to the best of our knowledge, we provide the first comprehensive analysis of the nominal assets and liabilities of various economic agents in Canada as well as the maturity structures underlying these portfolios. By so doing, we also show that nominal portfolios in Canada and the U.S. are different in the

1 See Mishkin and Schmidt-Hebbel (2001) and Svensson (2007) for views regarding the success of inflation-targeting.

2 See the background document to the 2006 renewal (Bank of Canada 2006).

3 Under price-level targeting the central bank corrects any deviations of the price level from its targeted path.

sense that middle-aged Canadians are savers on average, while their American counterparts are borrowers on average. Second, using the documented nominal portfolios, we offer an assessment of the redistributional effects of inflation that arise from the revaluation of nominal assets and liabilities in Canada. Third, we compare the extent of redistributions between Canada and the U.S. and show that large differences in redistributions can be realized even between countries with similar economic and legal environments.

Our approach follows the innovative work of Doepke and Schneider (2006), who developed a methodology to compute the redistribution of wealth. They consider the impact of inflation on direct nominal positions and indirect nominal positions that arise through equity holdings in businesses and investment intermediaries. We calculate the inflation-induced redistribution of wealth in two stages. First, using aggregate data from the National Balance Sheet Accounts (NBSA) and cross-sectional household data from the Survey of Financial Security (SFS), we document the nominal assets and liabilities of the foreign sector, the government sector, and several household groups. We highlight the role of pension assets and liabilities, many of which are sensitive to inflation. Second, using these nominal positions, we conduct the following experiment, which stresses the role of money as a unit of account for the valuation of nominal claims: if the real effects of inflation were primarily due to the revaluation of nominal assets and liabilities, who would lose and who would gain from a small inflation episode above expectation lasting several years during which inflation exceeds initial expectations by 1% beginning in a given benchmark year? Furthermore, how large would the transfers be and what would change as the inflation episode varies in magnitude between low and moderate episodes?

The answers to these questions depend on inflation expectations and on the way agents adjust their portfolios as these expectations are updated. Therefore, we report the results for two different scenarios: a full surprise scenario, where the inflation episode is unanticipated, and a gradual inflation scenario, where the path of the inflation episode is partially anticipated. In general, the latter provides a lower bound on gains and losses, while the former provides an upper bound. In the full surprise scenario, the maturity structure of nominal portfolios is irrelevant to the present value of gains and losses, which depend only on the initial nominal positions and the inflation shock. In contrast, under the gradual inflation scenario, the maturity structure also matters for the present value of gains and losses. Specifically, gains and losses are larger for positions with longer maturity.

In the first stage of the analysis, we document sectoral and household-level facts that are important for computing the effects of inflation on the redistribution of wealth. The stylized facts at the sectoral level can be summarized as follows. First, overall, the government is the main net nominal borrower and the household sector is the main net nominal lender. Additionally, the foreign sector's net nominal position is small. It began in the early 1990s as a nominal lender and shrank over the course of the decade; with government debt

decreasing, it emerged as a borrower in late 2006. This result contrasts with the experience in the U.S., where Doepke and Schneider (2006) show the foreign sector is both very large and a major lender. Second, since the beginning of the 1990s, there has been a move from short-maturity nominal instruments to longer-maturity nominal claims. For example, households have become borrowers mainly through mortgage debt and savers chiefly through long-term bonds and pensions. This shift towards long-term contracts may have been driven by several complementary forces such as (i) recent developments in financial markets that permit households to increase their nominal savings through pensions and mutual funds, (ii) the implementation of an inflation-targeting regime in 1991 that contributes to a partial reduction in price-level uncertainty, and (iii) the increased issuance of long-term government debt. Third, a significant part of the household sector's nominal assets is held in the form of pension assets. A large fraction of these assets consists of employer-sponsored defined benefit pension plans that are non-indexed.

The facts about the household sector are obtained by using the SFS data, where we divide the population by age and economic class. Generally, old households are net nominal lenders and young households are net nominal borrowers. As a proportion of household net worth, young middle-class households are the largest borrowers in the mortgage market and the young poor borrow significantly in the form of student loans. Old rich households are the major lenders in long-term bond markets, while old middle-class households hold the largest part of pension assets in the form of defined benefits. Poor old households save mostly using short-term nominal instruments.

Contrasting these household-level stylized facts with those from the U.S. as documented by Doepke and Schneider (2006), we show that most net nominal positions across age cohorts and economic classes are relatively similar between the two countries, while the nominal positions of middle-aged, middle-class households differ substantially. Specifically, while U.S middle-aged middle-class are large borrowers, their Canadian counterparts are large savers.

We now turn to the findings of the second stage of our work, where we present winners and losers from an inflation episode. On the losers' side, we find that rich and old households stand to lose, since inflation reduces the real value of their nominal assets. In the benchmark year 2005, the household sector loses up to 1.90% of GDP when there is a small inflation episode during which inflation exceeds expectations by 1% for five years. The elderly (i.e., above age 75) rich and middle-class households lose the most and their losses go up to 1.43% and 1.64% of their average net worth, respectively. More generally, rich households over age 46 and middle-class households over 56 bear most of the household sector's losses, mainly owing to their positive positions in long-term bonds and pension assets. Older poor households also suffer some losses, though these result from their positive short-term positions. On the winners' side, young middle-class households under age 36, which are the major holders of fixed-rate mortgage debt, are big winners; they account for a large part of the sector's gains. At most,

their gains amount to 4.34% of their average net worth. The government sector, a net nominal borrower, also benefits from inflation. In the benchmark year 2005, the gain of the government from the small inflation episode is up to 2.03% of GDP. Foreigners lose, but not substantially, since they were small net nominal savers in 2005. Specifically, their losses from a low inflation are up to 0.13% of GDP.

The shift towards long-term instruments since the 1990s also has important implications for the size of the inflation-induced redistribution of wealth, particularly under the gradual inflation scenario in which gains and losses are larger for longer maturity nominal claims than for short instruments. As a result, the effects become similar between unanticipated and partially anticipated inflation episodes. For example, the household sector's 2005 losses during a gradual inflation episode total 72.11% of its losses with unanticipated inflation, while in 1999 the figure was 66.37%. Similar changes occurred in the foreign sector and in government.

Furthermore, we compare the extent of redistributions between Canada and the U.S. – two countries with similar economic and legal environments. In doing so, we replicate the analysis of the inflation scenario that Doepke and Schneider (2006) conduct for the U.S. with our Canadian data. With the nominal positions of the benchmark year 2001, Doepke and Schneider assume that 5% inflation shocks persist for 10 years. Our comparison of the results suggests a striking difference between the two countries. The household sector as a whole in Canada could lose the value of net worth by as much as 16% of GDP, while the U.S. households would lose it by only 1.2% of their GDP. The difference arises as follows. Since the mid-1990s, the household sector's positive nominal position (i.e., nominal savings) has continued to decline in both countries but at a faster pace in the U.S. than in Canada.[4] By 2001, the Canadian household sector still held nominal savings equivalent to more than 40% of GDP, compared with less than 20% of GDP in the U.S. This analysis shows that even among countries with similar economic and legal environments, such as Canada and the U.S., the redistributional effects of inflation can be quite different, owing to their differences in nominal asset and liability positions.

Finally, we conduct sensitivity analyses for the assumption of how we allocate the redistributions that occur in the business sector to other sectors. Our baseline assumption is that business equity holders (i.e., owners of businesses) indirectly receive those redistributions, given that there are no frictions to prevent it. However, there may be endogenous reactions in pricing or wage-setting decisions by businesses to offset the gains or the losses of the value of their positions. We explore these alternative assumptions to allocate the business sector redistributions. We find that the level of relative gains and losses of different household groups changes, but the qualitative results remain the same.

4 During this period in the U.S., the declining household nominal savings were partly replaced by the increasing positive nominal position of the foreign sector, whereas in Canada the foreign sector's positive nominal position declined and remained small.

There are other papers that are related to our work. For Canada in the 1970s, Maslove and Rowley (1975) assess the redistributional consequences of inflation but focus on the expenditure effects that arise from the consumption pattern of households, while we focus on the wealth effects that come from the valuation of nominal assets and liabilities. The paper is also related to earlier literature, such as Bach and Stephenson (1974) and Cukierman, Lennan, and Papadia (1985), who document redistribution of wealth in the 1970s in other countries. However, they do not conduct their analyses within a unified framework where direct and indirect positions are considered together. Our focus on both sectoral and household data also distinguishes our approach from theirs. There is also literature that considers the welfare costs of inflation in monetary models where inflation affects the distribution of wealth (see Albanesia 2007; Erosa and Ventura 2002). Burnside, Eichenbaum, and Rebelo (2006) investigate the fiscal consequences of currency crises in emerging market economies. Their findings suggest that the devaluation of nominal government debt is a more important source of government revenue than seigniorage. Persson, Persson, and Svensson (1998) show that because of incomplete indexation of the tax system and the transfer program, moderate inflation has large effects. Finally, our work relies on detailed documentation of household assets and liabilities over the life cycle in Canada. In this literature, using household survey data, Milligan (2005) carefully documents life-cycle asset accumulation and de-cumulation in Canada. Our findings confirm those of Milligan (2005) that the portfolio share of financial (i.e., nominal) assets increases with age.

The remainder of the paper is organized as follows. In the next section we present the framework used to compute the inflation-induced redistribution of wealth. In section 3, we document nominal assets and liabilities in Canada, while in section 4 we use the methodology and nominal positions discussed in the previous two sections to estimate the redistribution of wealth implied by low and moderate inflation episodes. In section 5, we discuss the results of the comparison between Canada and the U.S. In section 6, we conduct sensitivity analyses regarding the treatment of the business sector nominal positions. We conclude in section 7.

2. Framework to compute the redistribution of wealth

The extent of the inflation-induced redistribution of wealth depends on how fast economic agents adjust their inflation expectations. We follow Doepke and Schneider (2006) by considering two inflation scenarios that provide in general upper and lower bounds on the redistribution of wealth. The upper bound is captured by a 'full surprise' scenario (hereafter FS). In this scenario, during multi-year shocks, agents do not anticipate that shocks will continue in subsequent periods; nominal interest rates remain unchanged and the inflation shock lowers the real value of nominal positions each period regardless of the duration of these

positions. The lower bound is given by an 'Indexing ASAP' scenario (hereafter IA), where agents adjust their expectations after the initial shock to take into account the full duration of the shock. This scenario is also known as a gradual inflation episode, since inflation is partially anticipated. Under the IA scenario, the nominal yield curve is adjusted upwards to incorporate the inflation shock. As a result, under the IA scenario, inflation-induced gains or losses depend on the maturity of the nominal position: the position is 'locked-in'at the pre-shock nominal interest rate until its maturity date but must be discounted using the new nominal rate, resulting in a lower present value. Intuitively, present value gains or losses for a claim are larger under the FS scenario because all the positions are affected equally by the inflation episode, while under the IA scenario long-term positions are affected more than shorter positions. Agents are able to mitigate their losses on instruments that mature before the inflation episode ends.

2.1. Full Surprise and Indexing ASAP scenarios

In this section, we discuss the formula to calculate the inflation-induced present-value gain or loss of a nominal claim given a certain term to maturity. The formula is specific to the underlying inflation scenario. Specifically, the formula for the FS scenario is independent of the term to maturity of the claim, whereas it incorporates the effect of the term to maturity for the IA scenario.

2.1.1. Full Surprise scenario

Consider an n-year, zero-coupon bond with a total nominal yield at time t of i_t^n. In the absence of unexpected inflation, the present value of one dollar earned in n periods through investment in this security is $V_t(n) = \exp(-i_t^n)$. Suppose that at time t, there is a one-time *surprise* increase in inflation of θ% per year that lasts for T periods. Under the FS scenario, since the inflation shock in each subsequent period is unanticipated, market expectations do not adjust and the nominal term structure is unchanged. As a result, only a proportion $\exp(-\theta T)$ of a position's present value remains; this proportion falls as the shock's size and duration increase. The present value, $V_t^{FS}(n)$, under FS is thus given by

$$V_t^{FS}(n) = \exp\left(-i_t^n\right)\exp(-\theta T) = V_t(n)\exp(-\theta T). \tag{1}$$

Equation (1) shows that the present value of a one-dollar claim at time t is independent of the maturity of that claim. The present value gain or loss G^{FS} is given by the following expression:

$$G_t^{FS} = V_t^{FS}(n) - V_t(n) = V_t(n)\left[\exp(-\theta T) - 1\right]. \tag{2}$$

As equation (2) shows, the net present value of gain or loss depends only on the size and duration of the shock and the initial nominal position. The gain is, indeed, proportional to the pre-shock position with a coefficient $[\exp(-\theta T) - 1]$. If $G^{FS} > 0$, then there is a gain from the inflation episode and otherwise there

is a loss. In the sections that follow, equation (2) will be used to compute the size of the redistribution under the FS scenario.

2.1.2. Indexing ASAP scenario

The Indexing ASAP scenario corresponds to a one-time *announcement* at period t that starting from the current period t, inflation will be θ% higher than expected in each period for the next T periods. Assuming the announcement is credible, bond markets will *immediately* revise their inflation expectations and incorporate these updates into the nominal yield curve. Assuming that the real yield curve does not change after the shock and that the Fisher equation holds, the new nominal interest rate used to discount a claim is $\widehat{i}_t^n = i_t^n + \theta \min\{n, T\}$. Therefore, the present value, V_t^{IA}, of a claim under IA is

$$\begin{aligned} V_t^{IA}(n) &= \exp\left(-\widehat{i}_t^n\right) = \exp\left(-i_t^n\right)\exp(-\theta \min\{n, T\}) \\ &= V_t(n)\exp(-\theta \min\{n, T\}). \end{aligned} \tag{3}$$

As can be seen from equation (3), in contrast to the FS scenario, under the IA scenario a nominal position of maturity $n < T$ will be impacted only for the n periods of its duration before which the agent is assumed to reinvest at the pre-shock real yield. This is analogous to the agent reinvesting in a claim that offers a nominal rate of return that has been indexed to take the inflation announcement into account. The present value gain or loss of a claim of maturity n under IA is given by

$$g^{IA}(n) = V_t^{IA}(n) - V_t(n) = V_t(n)\left[\exp(-\theta \min\{n, T\}) - 1\right]. \tag{4}$$

Equation (4) shows that, under IA, the present value gain or loss, $g^{IA}(n)$, of a claim depends on (i) the inflation shock (θT), (ii) the initial nominal position ($V_t(n)$), and (iii) the maturity of the claim (n). On the other hand, as mentioned above (see equation (2)), the gain or loss under FS for any position is independent of its duration. The IA scenario provides a lower bound for gain or loss on a claim, since it assumes full adjustment of expectations to the path of inflation following the initial announcement. This scenario additionally captures important qualitative features of a gradual inflation episode, during which this path is partially anticipated.[5] The total gain of an economic agent (e.g., a sector or a household group) is given by G^{IA} and defined as follows:

$$G^{IA} = \sum_n g^{IA}(n). \tag{5}$$

5 Therefore, we treat gradual inflation and IA scenarios as though they were interchangable.

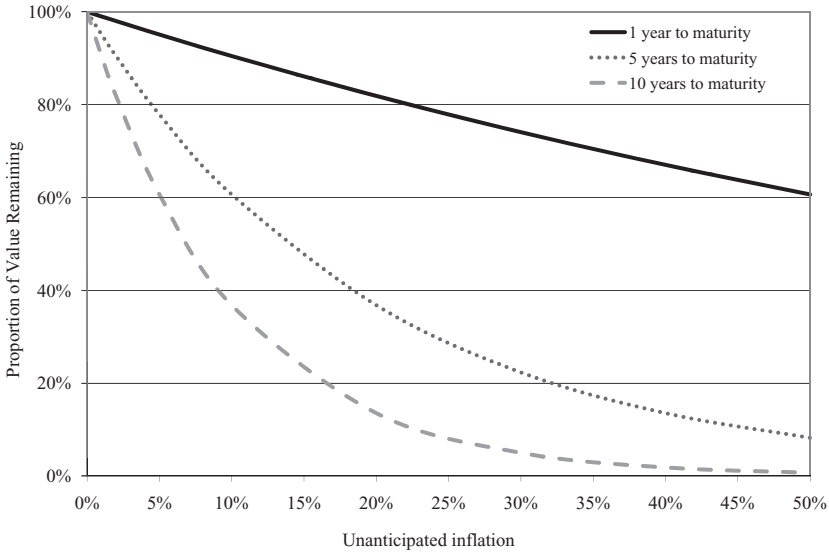

FIGURE 1 Relationship between inflation and remaining value of a position under the indexing ASAP scenario

2.1.3. Size of the inflation shock

As was just discussed, the duration of a claim matters under the IA scenario but not under the FS scenario, where the only relevant variables are the initial net nominal position and the inflation shock. One question that arises is how the size of the inflation shock interacts with the duration of a claim under the IA scenario when determining the extent of gains and losses.

The relationship between the maturity and the loss in asset value is non-linear under IA. It is illustrated in figure 1, which plots as a function of inflation the remaining value of three nominal assets with different durations. The solid, dotted, and dashed lines represent assets of maturity 1, 5, and 10 or more years, respectively. The dashed line also represents all maturities under the FS scenario for the case $T = 10$. Under FS, all positions are reduced by the same proportion, while under IA, positions with short and long maturities are reduced in different proportions.

A few points are apparent from the figure. First, for a given inflation shock, assets with shorter maturity retain more of their value. Second, when the inflation shock increases, assets with shorter maturity lose less value than those with longer maturity. For example, when the inflation shock is 10%, the remaining values are about 95%, 65%, and 40%, respectively for assets with 1, 5, and 10 or more years to maturity, while the remaining values are 85%, 40%, and 15% for the same durations when the shock rises to 20%. Finally, when the shock is sufficiently high, the values of all assets, regardless of maturity, converge to zero. This suggests

that for very high inflation, duration plays a relatively small role in determining the inflation-induced wealth redistribution and therefore the differences between FS and IA scenarios shrink.[6]

3. Nominal assets and liabilities in Canada

In order to assess the redistribution of wealth induced by inflation, it is essential to identify the nominal positions. As a result, in this section we document comprehensively nominal assets and liabilities of several economic sectors and groups of households in Canada.

3.1. Construction of direct and indirect nominal positions

In this section, we provide an overview of the methods and specific variables used to construct net nominal positions. A detailed presentation of these methods and variables can be found in the technical appendix of Meh and Terajima (2011). We define *nominal* assets and liabilities to be all nominal securities denominated in *Canadian dollars*. We observe four sectors of the economy: household, government, foreign, and business. Since the business sector is entirely owned by other sectors through their holdings of equity, we define the household, government, and foreign sectors to be the three *end-user* sectors, where the redistributional effects on the business sector are indirectly carried over to the end-user sectors through the equity claim they hold against businesses.[7] The computation of the net nominal position involves the indirect positions (through equity holdings) of a sector or a group of households. Therefore the net nominal position (NNP) of a sector or a household group is the difference between the market value of its nominal assets and liabilities, both direct and indirect.

We can make various assumptions to compute the indirect nominal position. In the baseline case, we follow McGrattan and Prescott (2005) in taking a frictionless approach to the valuation of the business sector. More specifically, we make the assumption that net equity is equal to the market value of real assets of the business sector plus the direct nominal positions (DNP) of the business sector. This assumption implies that net present values of assets and liabilities of businesses exactly equal the values of their stocks (i.e., the values to the business

6 Given that there is a non-linear relationship between a nominal claim's value and the inflation shock, it is possible, depending on the portfolio's maturity structure, that an agent could gain under the FS scenario but lose under the IA scenario or vice versa. For example, an individual, who borrows short term and invests part of his borrowing into long-term bonds, gains from inflation under the FS scenario but can lose under the IA scenario.

7 One can also argue that the government is 'owned' by households in the economy. Under such assumption, the redistributions that occur with respect to government nominal positions should be reallocated to households. Meh, Ríos-Rull, and Terajima (2010) analyze this issue and find that the government policy to reallocate windfall gains from inflation can lead to sizable aggregate and welfare effects.

owners). Hence, when the value of assets and liabilities unexpectedly changes, it is directly reflects in the value of the stocks. Net equity is defined as the market value of all equity claims on domestic firms not possessed by other domestic firms. Therefore, we compute the ratio η^s of each sector's equity holdings, E^s, to net equity holdings within the economy, E, as

$$\eta^s = \frac{E^s}{\sum E^s} = \frac{E^s}{E},$$

where s indicates a sector and $s \in \{H, G, F\}$ for the household, the government, and the foreign sector, respectively.

For the average household within each household group,[8] h, the ratio of this household's equity to all equity held by households, η_h^H, is

$$\eta_h^H = \frac{E_h}{E^H} = \frac{E_h}{\sum E_h}.$$

An indirect nominal position (*INP*) for each sector is obtained by multiplying its equity holdings as a proportion of net equity holdings within the economy by the direct nominal position (*DNP*) of the business sector. This represents the particular sector's indirect holdings of assets and liabilities through its claims on corporations:

$$INP^s = \eta^s \, DNP^B,$$

where DNP^B is the direct nominal position of the business sector. The net nominal position (*NNP*) of a particular sector is then

$$NNP^s = DNP^s + INP^s.$$

At the household-level, we compute the *INP* for the average household within each household group as

$$NNP_h^H = DNP_h^H + INP_h^H.$$

The shares, η^s, for each aggregate sector are derived from the NBSA data, while the shares, η_h^H, for the average household within each household group are derived from the SFS data.

The frictionless approach to the valuation of the business sector implies that household equity holdings represent the net value of nominal and real assets and liabilities of the business sector. Thus, we define the net worth of a household to include the value of its direct nominal position and real holdings as well as

8 Household groups will be defined later according to age and economic class.

the value of the indirect nominal and real holdings associated with its equity position.

3.2. Data

Our main data source for computing the positions of government, foreign, household and business sectors is the National Balance Sheet Accounts (NBSA) from 1990:1 to 2007:4, as provided by Statistics Canada.[9] The NBSA document the ownership of financial and non-financial assets by sectors. Specifically, it details assets and liabilities for persons and unincorporated businesses, corporations (including investment intermediaries), governments (at the federal, provincial and municipal levels), and non-residents. In our study, these sectors identify respectively the household, business, government, and foreign sectors that we discussed in subsection 3.1.

For detailed household nominal positions, we use the 1999 and 2005 versions of the Survey of Financial Security (SFS), which provides microdata on income and wealth collected by Statistics Canada.[10] The 1999 survey involved 15,933 households and the 2005 survey involved 5,267 households with weights to produce Canadian aggregates. These microdata provide a comprehensive picture of assets, liabilities, and wealth. The SFS also over-samples the rich, since they own a disproportionate share of the economy's assets. For our analysis, we mainly use the 2005 version of the SFS but also consider the 1999 data in order to identify changes in nominal positions over time.

As previously mentioned, after 1990 values of assets and liabilities are given as market values within the NBSA by Statistics Canada. For financial positions, the total values of liability-side bonds and equity have been estimated directly in the NBSA; asset-side figures are then linked to these estimates. The market value for shares of all listed companies is based on information taken from the exchanges and reconciled to survey data. Assets of the major domestic institutional sectors (e.g., pension funds, segregated funds of life insurance companies, mutual funds) are converted to market values based on data in Statistics Canada surveys. The market value of the non-resident sector's assets is estimated by Statistics Canada using microdata in a debt inventory system, as are domestic bond liabilities. Therefore, unlike Doepke and Schneider (2006), we do not impute market values from payment streams within our data set.

9 There are data from the NBSA prior 1990, but only book values are reported, not market values. Since maturity and interest rate data are not readily available to impute the market values for the periods before 1990, we start from 1990. The methodology for constructing market values within the NBSA is given in the Statistics Canada release 'Balance Sheet Estimates at Market Value' (24 June, 2004) from the series 'Latest Developments in the Canadian Economic Accounts', available at: http://www.statcan.ca/english/freepub/13-605-XIE/2003001/conceptual/2004marketvalue.htm

10 The SFS is also available for 1984. However, the 1984 survey involved significantly fewer variables. The variables and structure of the SFS are relatively consistent between the 1999 and 2005 data sets.

3.3. Categories of nominal instruments

We define four broad categories of nominal financial instruments: short-term instruments, long-term bonds, mortgages, and employer pension plans.[11] For the purpose of our study, all nominal assets and liabilities of sectors and household types are assigned to one of these categories.

Assets held within Registered Retirement Savings Plans (RRSPs) are assigned to one of these categories. In the 2005 SFS data, the values of assets within RRSPs are documented, and therefore we assign RRSP assets to short-term instruments, long-term bonds, and equities.[12] We also compute the equity holdings in public corporations for the purpose of deriving each household type's η_h^H and INP_h. Since the NBSA includes the assets of private corporations within the household sector, we do not consider ownership of private corporations as equity. (The series aggregated into each category of instrument are detailed in the technical appendix of the paper.)

Short-term instruments. Short-term instruments are assets and liabilities with a term-to-maturity of one year or less and include the following items: domestic currency, bank deposits, other deposits, consumer credit, Canada short-term paper, other short-term paper, trade accounts receivable and payable, IMF reserve positions, and short-term components of foreign investments.

Mortgages. In this study, we employ distributions over remaining terms for fixed-rate mortgages. Figure 2 presents the 2005 distribution, weighted by outstanding balances. It shows that most Canadian fixed-rate mortgages have remaining terms-to-maturity of less than five years. Five-year-term mortgages are most common in Canada. Fixed-rate mortgages account for a significant fraction of all mortgage debt, although there has been a shift towards variable mortgage rates. For example, fixed-rate mortgages accounted for 80% and 90% of all mortgages in 1999 and 2004, respectively. We produce these distributions using data recorded in the Canadian Financial Monitor (CFM), an annual household survey conducted by Ipsos Reid.[13] The data set contains information on original terms of mortgages and the duration in which the household has accounts with the financial institution. Remaining terms of mortgages are imputed based on available information.

11 We separate mortgages as in Doepke and Schneider (2006), but we also separate pensions from long-term bonds. In Doepke and Schneider (2006), pensions are included in other long-term instruments. Pensions and mortgages are specially treated because they have recently attracted attention from academics and policymakers.

12 In the 1999 SFS, only an aggregate value is available for RRSP assets. For simplicity, we decompose this aggregate between short instruments, mortgages, long instruments, and real assets according to the proportions of 2005 RRSP holdings for each of these asset categories.

13 Unfortunately, these data are not available prior to 1999, so we have assumed that the 1999 distribution holds over the 1990–1998 period.

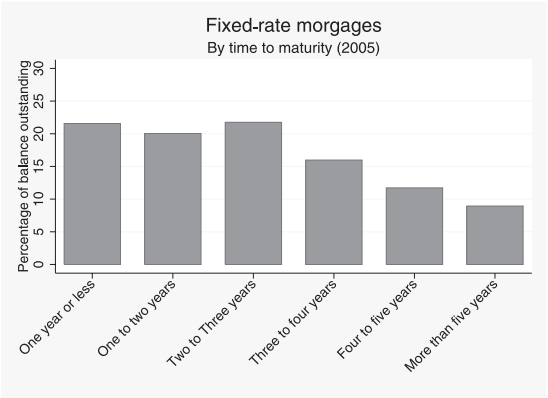

FIGURE 2 Distribution of fixed-rate mortgages by remaining term to maturity, 2005

Long-term bonds. The bond category comprises non-mortgage and non-pension instruments with maturity greater than one year and includes the following NBSA categories: Canada bonds, provincial bonds, municipal bonds, corporate bonds, and other bonds, bank loans, other loans, government claims, long-term components of foreign investments, and other financial instruments that have not been assigned to the mortgage, pension, or short categories. For our purposes, we employ distributions over terms-to-maturity for these items in this category. We derive these distributions from three sources: face values and maturities of federal government debt, corporate bonds, and bank loans outstanding.

Federal government debt data were provided by the Bank of Canada's Financial Markets Department, drawn from the Communication, Auction and Reporting System database and supplemented by data provided by Statistics Canada. Corporate bond data are from the Merrill Lynch Canada Corporate Index, which tracks the performance of Canadian-dollar denominated investment-grade corporate debt publicly issued in the Canadian domestic market. Bank loan data were drawn from Reporting Form I3 'Interest Rate Risk and Maturities Matching Return' of the Office of Superintendent of Financial Institutions. More detailed information on these data is provided in the technical appendix. The outstanding values of these three items make up 50% to 60% of the whole long-term bond category over the period. We assume, when dealing with the IA scenario (which requires details on the portfolio's maturity structure), that the distribution of terms-to-maturity for weighted long-term securities we calculated above approximates the distribution of terms-to-maturity for the long-term bond category.

Figure 3 displays the distributions of terms-to-maturity of these three subcategories of long-term bonds in 2005. The left panel of figure 3 displays the terms-to-maturity distribution of government bonds. It shows that there are sizeable amounts of outstanding bonds with term-to-maturity longer than 20 years.

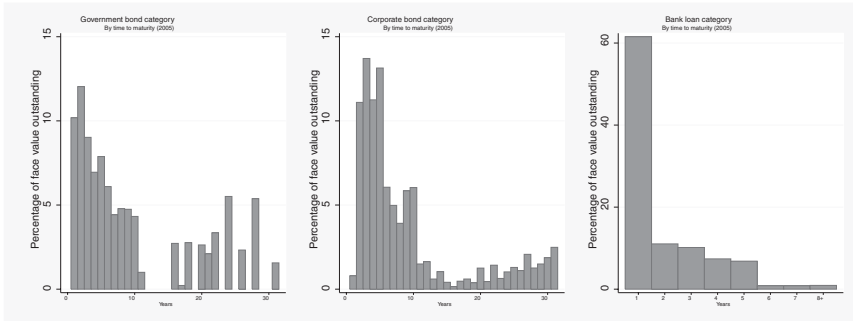

FIGURE 3 Distribution of outstanding long-term securities for December 2005

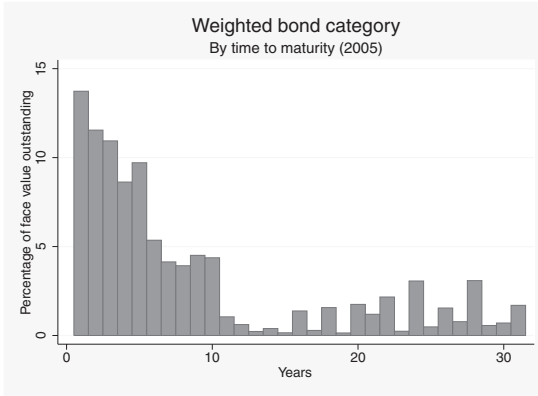

FIGURE 4 Distribution of weighted outstanding long-term securities for December 2005

The middle panel shows the distribution of corporate bond terms. We observe more than 20% of corporate bonds have terms longer than 10 years. Terms to maturity of bank loans are shown on the right panel, the majority (60%) of bank loans have terms less than or equal to one year, with the rest spreading mostly over two to five years. For each year that data are available, we derive the distribution for the bond category by taking the outstanding-value-weighted average of terms-to-maturity over these three items. During the 1990 to 2007 interval, the weighted-averaged term-to-maturity for outstanding long-term bonds was between five and nine years. Figure 4 shows the derived distribution of terms-to-maturities that we apply for the category in 2005.

Pensions. We differ from Doepke and Schneider (2006) in our treatment of pensions. They assume that all nominal risks associated with pensions are born by the business sector, implying that there is no direct effect on households from inflation shocks. A large fraction of employer-sponsored pensions in Canada are

of the non-indexed defined benefit type, with benefit payments that are directly subject to inflation shocks. Furthermore, defined contribution pensions are also subject to the shocks and the magnitude of the effect depends on the portfolio in which contributions have been invested. As a result, it is important for us to pay closer attention to pensions when studying the Canadian economy.[14]

There are three types of employer pension plans (EPPs), among which we distinguish: non-indexed defined benefit, indexed defined benefit, and defined contribution. Defined benefit plans are those in which the plan pays the beneficiary based on a benefit formula, typically involving years of service and average earnings. Furthermore, defined benefit plans may involve provisions for indexation. Under defined contribution plans, contributions to a managed fund are made on an employee's behalf with beneficiaries receiving benefits at retirement based on the value of their contributions and the performance of the portfolio. These positions are affected differently by an inflation shock: fully indexed defined benefit EPPs are treated as real positions and hence are not affected by inflation shocks. If a plan is not fully indexed, for our purposes, we consider it non-indexed.[15] While non-indexed defined benefit plans are impacted as are any nominal assets under the full surprise scenario, the impact on these plans under the Indexing ASAP scenario is a function involving the years to retirement and years to life expectancy. Defined contribution plans hold a portfolio of assets, managed by the plan sponsor or their agent. The impact of inflation on a household's assets in a defined contribution plan will depend on the overall impact on this portfolio.

3.4. Sectoral nominal positions

The present value gains or losses in a sector's net nominal positions under our two inflation scenarios depend on the initial nominal positions within each category of assets and liabilities. Figure 5 summarizes the evolution of net nominal positions (NNPs) over the 1990 to 2007 interval for the household, government, and foreign sectors (i.e., end-user sectors). To understand the indirect positions, we also report in figure 6 the evolution of the business sector's direct nominal position (DNP).[16] Recall that the business sector's positions in each instrument are assigned to the three end-user sectors as indirect positions, based on their equity holdings.

Figure 5 shows that Canadian households are the main lenders in Canada and that the government is the main borrower. Household saving and government borrowing peaked in the mid-1990s and declined thereafter.[17] Relative to the other two sectors, the foreign sector is small in terms of nominal borrowing and

14 Although privately managed, a large portion of these employer-sponsored pension plans is found in the public service sector, for example, the Ontario Teachers' Pension Plan.

15 Since some plans we classify as non-indexed may be partially indexed, we consider the fraction of non-indexed pension plans that we use to be the upper limit.

16 Note that the business sector includes both financial and non-financial businesses.

17 The decline in the government's nominal debt is due to the fact that debt was being serviced out of surpluses realized in the late 1990s.

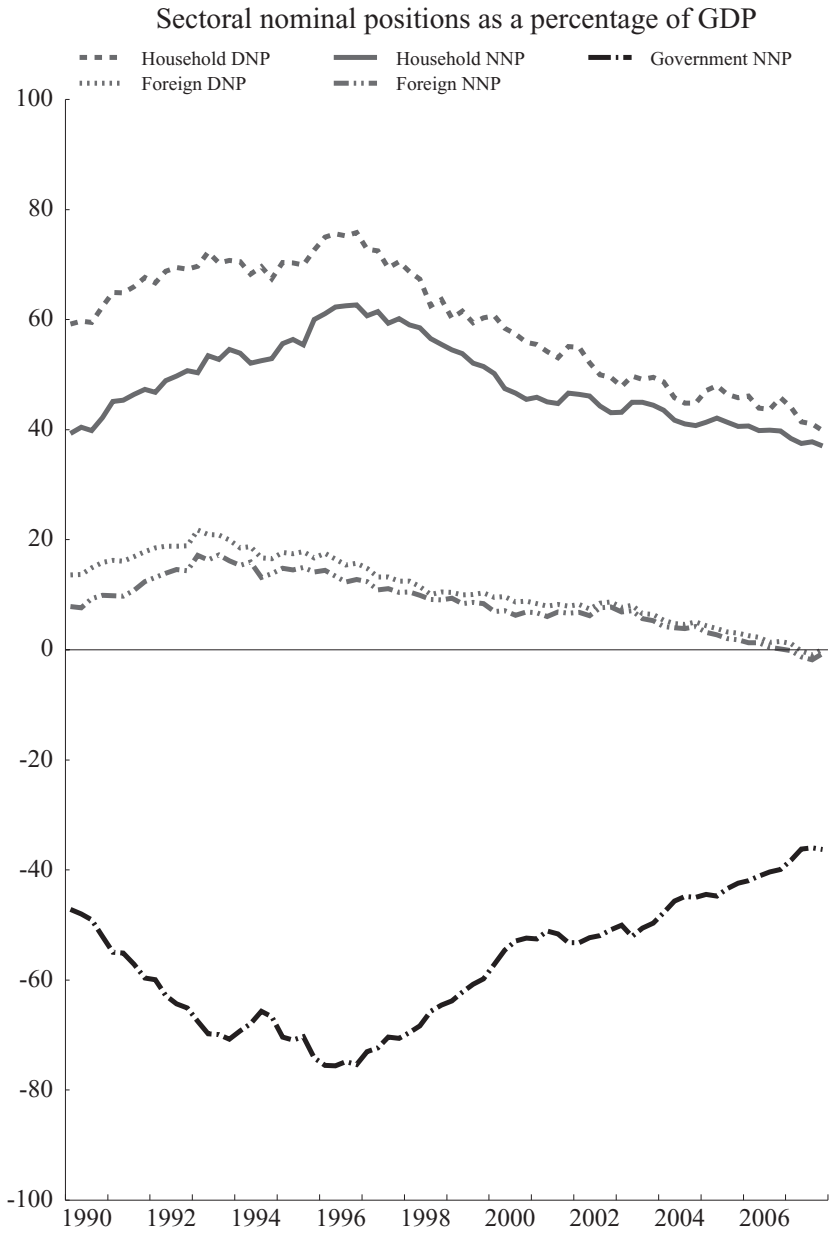

FIGURE 5 Sectoral nominal positions in the canadian economy as a percentage of GDP from 1990 to 2007

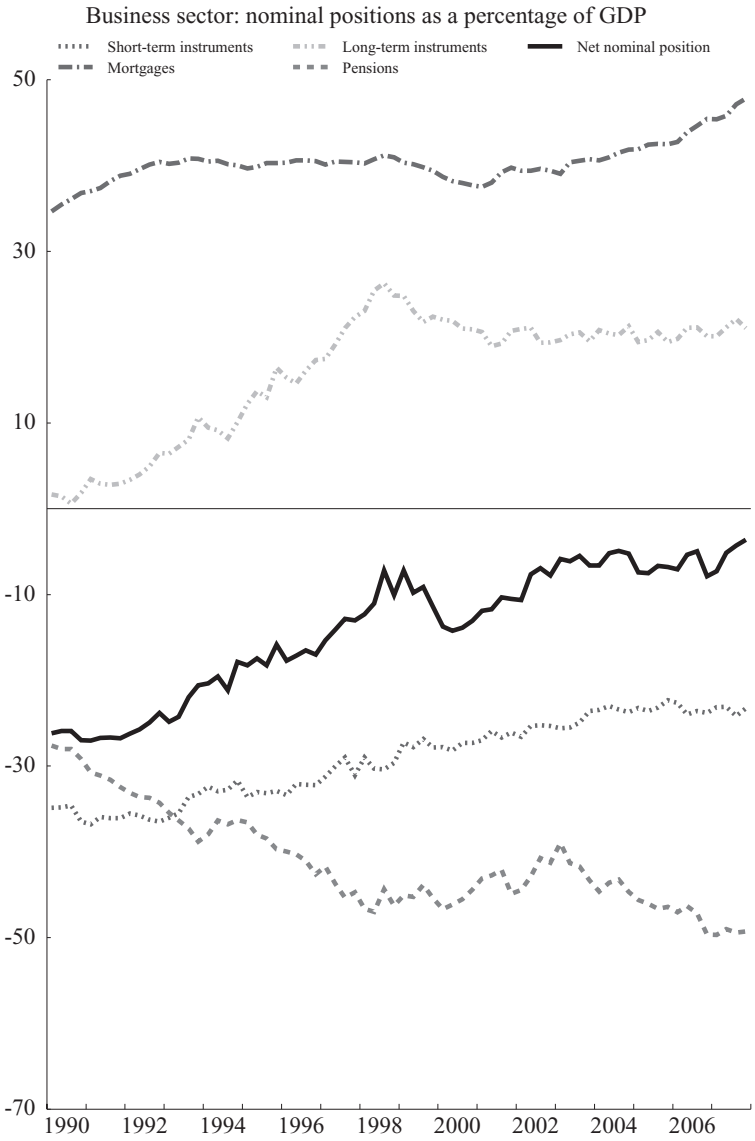

FIGURE 6 Direct nominal positions of the canadian business sector as a percentage of GDP from 1990 to 2007

lending. This sector was a lender in the 1990s, though it declined in importance over the decade; recently, it has become a borrower, particularly, since late 2006. The foreign sector data also contrast with experience in the U.S., where the foreign sector has been, since the late 1980s, a major net nominal lender (Doekpe

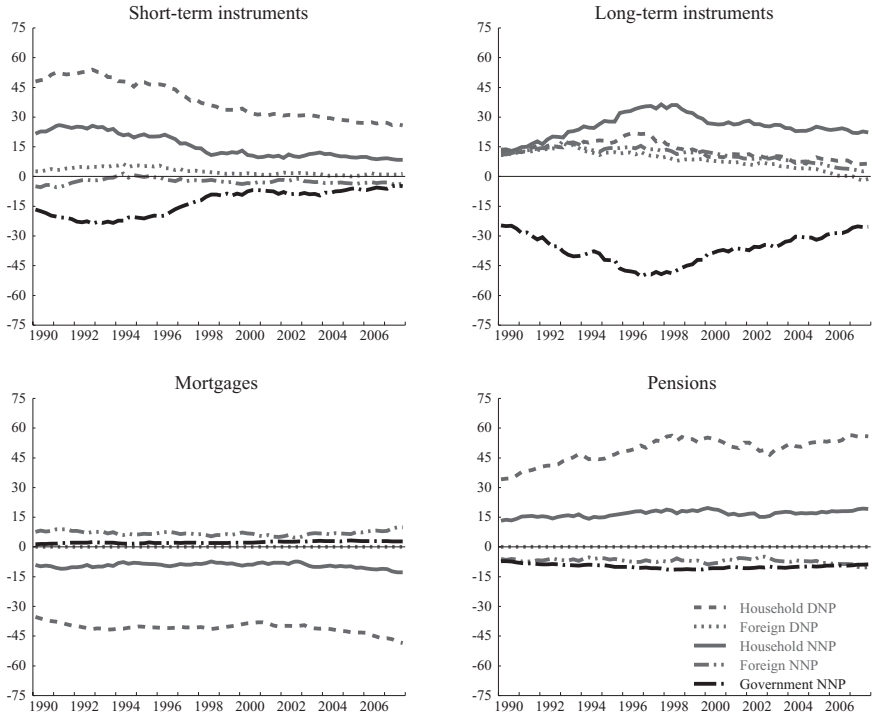

FIGURE 7 Sectoral positions in various nominal asset categories in the Canadian economy as a percentage of GDP from 1990 to 2007

and Schneider 2006). The household sector's indirect position is negative (i.e., indirect debt) and decreasing in absolute value, as is evident from the negative difference between its NNP and DNP.

What type of instruments are used by the different sectors for nominal borrowing and lending? Figure 7 attempts to address this question by summarizing the sectoral nominal positions in different asset categories: short instruments (panel a), long instruments (panel b), mortgages (panel c), and pensions (panel d). The scales in all four panels in figure 7 are identical, so that the sum of a sector's net positions in panels a, b, c, and d equals its position in figure 5.

Several interesting observations can be made from the plots shown in figure 7. The figure shows that government is a net borrower, especially in long-term claims, except for mortgages. The household sector is mainly a net nominal lender in long-term bonds and pensions and a net borrower in the mortgage market; long-term bonds are their major nominal savings instrument. Both the pension assets held directly and the pension liabilities held indirectly through equity holdings have increased, since 1990. Therefore the positive net nominal pension asset position, expressed as part of GDP, has not changed much. The household

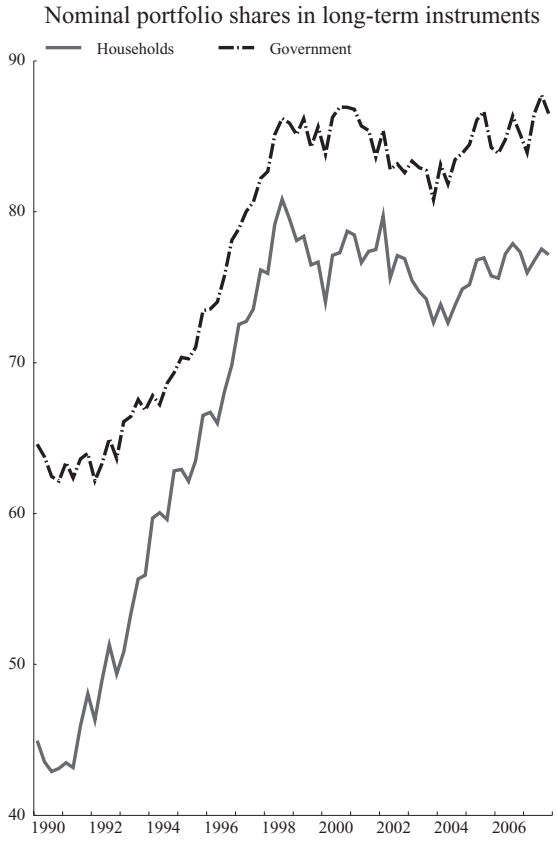

FIGURE 8 Fraction of net nominal positions in long-term instruments

sector's net nominal positions in long-term bonds increased dramatically through the late 1990s. After a slight decline, they levelled off to around 30% of GDP in the 2000s. The positions in short-term instruments decreased, since 1993 as long-term nominal claims grew.

Figure 8 further illustrates the growing importance of longer maturity instruments in nominal financial markets by plotting the ratio of net nominal position in longer maturity claims to total net nominal position for the household and government sectors from 1990 to 2006. We can see that the use of long-term instruments accelerated through to the late 1990s. In the 2000s, they remained at a level between 70% and 80%. The fraction of total nominal household savings in long-term financial instruments has increased from about 44% in 1990 to more than 74% in 2006.

Several factors may explain these shifts towards long-term contracts. First, recent financial developments have allowed households (particularly baby

boomers) to increase their nominal savings for retirement through pension plans and mutual funds; as a result, their nominal holdings have moved towards long-term assets. Second, the implementation of an inflation targeting regime in 1991 contributed to a reduction in long-run price level uncertainty, which encouraged agents to enter into long-term nominal contracts. Third, the increased issuance of long-term government debt played a role in the holding of long-term bonds by households.

Figure 7 also shows that the foreign sector uses mainly longer maturity instruments for borrowing and lending. Specifically, it was a net borrower in pensions and a net lender in mortgage markets over the period 1990–2007. The foreign sector was also a lender in long-term bonds until 2003. For example, in the benchmark year 1999, foreigners had positive net nominal positions in long-term bonds of 12.34% of GDP. The direct nominal position of the foreign sector in the mortgage market is nearly zero. The NBSA assumes that the sector has no direct exposure to pensions in order to balance national supply and demand in the market for these claims. Therefore, the sector's positive net nominal position in the mortgage market and its negative position in pensions arise mainly through indirect exposures.

3.5. Nominal positions within the household sector

The previous section looked at nominal positions across different sectors of the economy. In this section, we use the SFS data to analyze in detail the household sector by documenting cross-sectional nominal positions for different groups of households. We divide the sample into groups based on age and income. We define six age cohorts based on the household head's age: under 36, 36–45, 46–55, 56–65, 66–75, and over 75. Within each age cohort we identify households as *rich*, *middle-class*, and *poor*. Rich households are defined as those in the top 10% of the wealth distribution. We resort the remaining 90% of households by income. Poor households are those in the bottom 20%. The remaining 70% of each age group is assigned to the middle class.

Net nominal positions for the benchmark year 2005. Table 1 describes the net nominal positions and the nominal portfolio for different income classes and age groups in the benchmark year 2005. (Much more detailed observations in terms of indirect and direct nominal positions are provided in table A9 in the technical appendix.) Table 1 shows that, overall, young households are net nominal borrowers and old households are net nominal lenders.[18]

There is, however, heterogeneity within age groups in terms of borrowing and lending. For example, in the two age groups under 46, the middle class and the poor borrow, while the rich between ages 35 and 46 save. In fact, with the

18 The table shows that NNPs of households generally increase with age. This observation confirms the finding of Milligan (2005) that the portfolio share of financial (i.e., nominal) assets increases with age.

TABLE 1
Nominal positions as a fraction of the mean net worth of each age and income class in 2005

Type of instrument	Age cohort ≤35	36–45	46–55	56–65	66–75	>75
	All households					
Short	4.64	−1.26	1.21	2.13	8.84	12.13
Mortgage	−37.66	−13.33	0.25	4.63	3.62	3.35
Bond	−2.63	4.66	6.45	7.85	6.66	7.65
Pension	−0.19	−1.51	4.77	7.12	8.55	8.55
Total NNP	**−35.84**	**−11.44**	**12.68**	**21.73**	**27.67**	**31.68**
	Rich households					
Short	3.64	−4.08	−2.41	−2.82	8.23	8.39
Mortgage	−11.10	4.92	13.12	13.87	7.26	5.78
Bond	7.65	9.64	11.63	12.86	10.43	12.30
Pension	−3.07	−8.77	−6.56	−7.08	1.21	3.05
Total NNP	**−2.88**	**1.70**	**15.78**	**16.83**	**27.13**	**29.52**
	Middle-class households					
Short	5.69	2.12	4.29	5.38	8.97	14.81
Mortgage	−81.34	−35.23	−11.02	−2.83	1.67	1.75
Bond	−18.07	−0.90	2.15	4.09	4.55	4.55
Pension	4.35	7.51	15.83	19.23	14.03	12.64
Total NNP	**−89.38**	**−26.51**	**11.26**	**25.86**	**29.21**	**33.75**
	Poor households					
Short	18.74	−0.28	4.80	13.66	12.15	10.82
Mortgage	−37.62	−19.23	−9.17	2.44	−2.44	2.16
Bond	−37.59	−3.53	0.15	2.58	1.36	6.03
Pension	4.32	−4.26	0.76	1.83	2.60	4.55
Total NNP	**−52.14**	**−27.29**	**−3.45**	**20.51**	**13.67**	**23.57**

exception of the youngest cohort (under 36), all rich age groups are net nominal savers. The positive net nominal positions of the elderly rich are large, and their ratio of net nominal savings to net worth (29.52%) is the second highest, preceded by the elderly middle class (33.75%). In contrast, middle-class households under age 36 have the highest ratio of net nominal debt to net worth (89.38%), followed by the young poor (52.14%). The poor on average remain borrowers later in life than other income classes. For example, poor households are borrowers until age 56, while middle-class households have stopped borrowing by age 46 on average.

Poor households save mainly through short-term nominal instruments (such as cash). In general, rich households save through real assets. However, to the extent they own nominal claims, rich households save through long-term nominal instruments, particularly those age 46 and up. The old and middle-aged middle class use more pensions in the form of non-indexed defined benefit assets for

their savings, compared to their counterparts among the poor and rich, who rely more on short-term and long-term instruments, respectively. Young middle-class households are the largest borrowers, and most of their direct borrowing occurs through mortgages. The ratio of their overall net nominal debt to net worth is 89.38%, while the ratio for mortgage debt is 81.34%.[19] The young poor have the second highest ratio of nominal mortgage debt to net worth, after the young middle-class. Only the young poor and the young middle-class hold negative positions in long-term bonds, which are largely due to student loans. Indirect nominal pension liabilities are substantial for the rich on account of their large equity holdings.[20]

4. Inflation-induced redistribution of wealth

In this section we use the nominal positions of the sectors and household groups, combined with the methodology developed in section 2, to estimate the redistribution of wealth induced by a five-year inflation episode during which inflation exceeds expectations by $\theta = 1\%$ every year, starting in a given benchmark year. This inflation episode roughly resembles the inflation experience in Canada between 2000 and 2005, when the average annual inflation rate was about 2.39%.

Our analysis considers the redistribution of wealth implied under FS and IA scenarios. The redistribution occurs because money is a unit of account for the revaluation of nominal assets and liabilities.

4.1. Redistribution across sectors

We first discuss the redistribution of wealth for the benchmark year 2005 and then we analyze changes in redistributive trends over time.

4.1.1. Sectoral redistribution of wealth in the benchmark year 2005

The first panel of table 2 summarizes, for the benchmark year 2005, the sectoral present value gains and losses induced by an inflation episode with 1% shocks that continue for five years under FS and IA inflation scenarios.

It is apparent from the first panel of the table that, under the two inflation scenarios in 2005, the household sector loses, while the government sector wins. Both the loss of the household sector and the gain of the government are large. Under FS, the loss of households amounts to 1.90% of GDP, while the gain of the government is 2.03%. The foreign sector loses but the loss is small, just 0.13% of GDP. To understand these findings, recall that, under FS, gains and losses are

19 Note that households could conceivably hold a positive net nominal position in mortgages. This is because their indirect mortgage position through shares held in financial institutions could be positive. As we would expect, all *direct* nominal mortgage positions are negative.

20 These households own the largest proportion of the sector's equity holdings and so have the largest indirect positions. See the technical appendix for more details.

TABLE 2
Redistribution of wealth across sectors as a percentage of GDP, with inflation episode of 1% inflation shock lasting five years

			Households		
Sectors	Government	Foreigners	Net	Gains	Losses
	Benchmark year 2005				
Full surprise scenario	2.03	−0.13	−1.90	12.40	−14.30
Indexing ASAP scenario	1.46	−0.09	−1.37	6.55	−7.92
	Benchmark year 1999				
Full surprise scenario	2.73	−0.50	−2.23	11.31	−13.54
Indexing ASAP scenario	1.84	−0.37	−1.48	5.83	−7.31

obtained simply by multiplying the initial nominal position by a constant factor ($\exp(-0.05) - 1 = -0.049$). Since the household sector is the economy's main lender and the government sector is the major borrower, it is not surprising that these sectors are most dramatically affected by the shock under the FS scenario.

It is also clear that gains and losses are generally smaller under the IA scenario. The loss of households under the IA scenario is 1.37% of GDP compared with 1.90% under FS. This change is driven by a reduction in the losses associated with the sector's net savings in long-term bonds and pensions relative to the FS case. The change is offset somewhat, since instruments with shorter maturity are less sensitive to gradual inflation, and the gains associated with the sector's net debt in mortgage markets shrink relative to the FS case. The gain of the government drops from 2.03% of GDP under the FS scenario to 1.46% under the IA scenario; this represents a decrease of 28.08%. It occurs because the government borrows in some long-term bonds that have maturities less than the five-year length of the inflation episode. The foreign sector's losses remain small-decreasing from 0.13% of GDP under FS to 0.09% of GDP under IA.

4.1.2. Sectoral redistribution of wealth over time

In the previous section, we considered in detail the sectoral redistribution of wealth implied by a small inflation episode above expectation that begins in 2005. In this section, we briefly discuss how our results would vary if we considered benchmark years 1990 through 2007.

Figures 9 and 10 present wealth gains and losses over time under FS and IA scenarios, respectively. Time on the horizontal axis is the benchmark years for the arrival of the five-year inflation episode, and the vertical line represents sectoral gains and losses as a percentage of GDP. For each year on the horizontal axis, we compute the wealth gain or loss by using sectoral nominal positions in that year. The gains and losses in figure 9 are proportional to the overall net

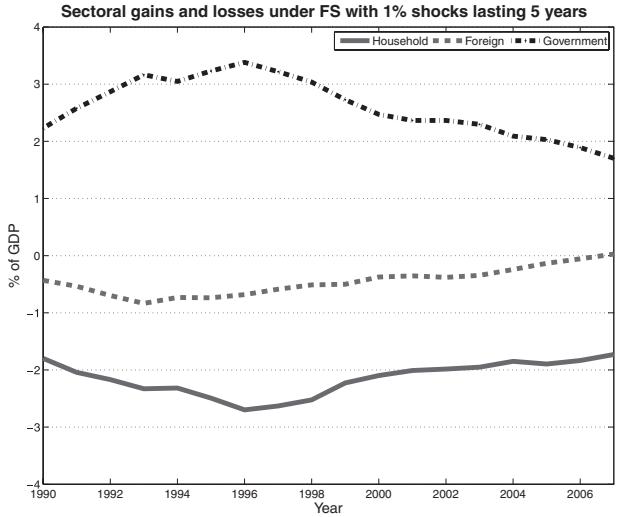

FIGURE 9 Sectoral gains and losses as a percentage of GDP under full surprise scenario, from 1990–2007

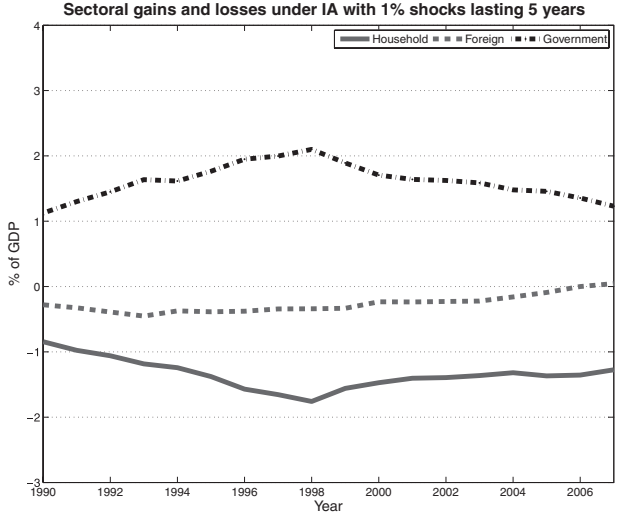

FIGURE 10 Sectoral gains and losses as a percentage of GDP under indexing ASAP scenario, from 1990–2007

nominal positions, and as a result this figure is a mirror image of figure 5. When we compare figure 9 and figure 10, we can see that the overall redistribution of wealth is higher under the FS scenario than under the IA scenario from 1990 to 2007. A key trend in both figures is that the government's gain began decreasing

TABLE 3
Redistribution of wealth across households as a percentage of the mean net worth of each age and income class in 2005, with inflation episode of 1% inflation shock lasting five years

Age group	<36	36–45	46–55	56–65	66–75	>75
	Full surprise scenario					
All households	1.74	0.56	−0.62	−1.05	−1.34	−1.54
Rich households	0.14	−0.08	−0.77	−0.82	−1.32	−1.43
Middle-class	4.34	1.29	−0.55	−1.26	−1.42	−1.64
Poor	2.53	1.32	0.17	−1.00	−0.66	−1.14
	Indexing ASAP scenario					
All households	1.08	0.25	−0.52	−0.75	−0.75	−0.75
Rich households	0.11	−0.08	−0.51	−0.52	−0.68	−0.75
Middle-class	2.64	0.62	−0.58	−0.96	−0.85	−0.77
Poor	2.02	0.85	0.14	−0.38	−0.19	−0.51

in the late 1990s. At the same time, the foreign sector's losses began to fall off. In late 2006, the foreign sector began to experience gains, because in that period foreigners became borrowers in nominal claims in Canada. This gain, however, is small. The household sector's losses peaked in the late 1990s and decreased until late 2006. These losses form almost the mirror image of the gains of the government.

To further illustrate changes in the inflation-induced redistribution of wealth over time, let us compare the benchmark year 1999 against 2005 (see table 2). It is evident from the table that the losses of both the household and foreign sectors as well as the gains of the government have decreased, since 1999 under both scenarios. For example, from 1999 to 2005 the loss of households decreased by up to 14.80% and the gain of the government fell by up to 25.64%.

4.2. Redistribution between household types

In this subsection, we report, for different groups of households, the redistribution of wealth induced by a five-year inflation episode of 1% a year commencing in the benchmark year 2005.

Table 3 reports the present value gains and losses as a percentage of the average net worth of each household group for the FS and IA scenarios.[21] Overall, regardless of the inflation scenario, young households win and old households lose. The main winners are young middle-class households, which owe large

21 Note that net worth used in the calculations of the table does not include the capitalized values of publicly administered pensions such as the Canada Pension Plan and the Quebec Pension Plan. Since poor households' present-value wealth likely consists of a high fraction of these pensions, relative gains and losses of poor households may be smaller if expressed as a fraction of net worth, including the capitalized value of public pensions. However, this adjustment will not affect the dollar values of the redistributions.

TABLE 4
Redistribution of wealth across households as a percentage of the mean net worth of each age and income class in 1999, with inflation episode of 1% inflation shock lasting five years

Age group	<36	36–45	46–55	56–65	66–75	>75
	Full surprise scenario					
All households	1.05	−0.02	−0.71	−1.16	−1.35	−1.45
Rich households	−0.04	−0.48	−0.69	−1.05	−1.41	−1.28
Middle-class	2.74	0.41	−0.78	−1.27	−1.35	−1.61
Poor	4.28	0.81	−0.24	−0.74	−0.84	−1.15
	Indexing ASAP scenario					
All households	0.56	−0.06	−0.54	−0.77	−0.74	−0.66
Rich households	−0.11	−0.33	−0.49	−0.66	−0.80	−0.60
Middle-class	1.57	0.18	−0.64	−0.88	−0.73	−0.73
Poor	3.17	0.50	−0.11	−0.39	−0.32	−0.35

fixed-rate mortgage debts. Their gain as a proportion of their mean net worth is large: about 4.34% under FS and about 2.64% under the IA scenario. The second group of winners is the young poor, who enjoy on average gains between 2.53% and 2.02% of their average net worth. The gains of the young poor come largely from their holdings of student loans and mortgage debt. More age groups benefit from the inflation episode among the poor than among the middle class or the rich under the full surprise scenario. This is because poor households remain net borrowers through to age 56; therefore, the youngest three groups among the poor are winners.

In general, older middle-class and rich households bear most of the losses under the two inflation scenarios. More specifically, under the FS scenario, rich and middle-class households over age 75 are the sector's greatest losers, with losses accounting respectively for 1.43% and 1.64% of their respective average net worth. These losses are largely due to their large nominal positions in long-term bonds and non-indexed defined benefit pensions. The table also shows that most rich households lose from the inflation episode.

4.3. Cross-sectional redistribution between 1999 and 2005

This section examines the changes in inflation-induced redistribution that arise through the revaluation of nominal claims across households between the two benchmark years 1999 and 2005.

Table 4 respectively presents the redistribution of wealth by household type under the FS and IA scenarios for the benchmark year 1999, while table 3 summarizes that of the benchmark year 2005. Overall, we can see from the tables that the gains of the young middle-class are larger in 2005 than in 1999.

Some of the large gains accruing to the young in 2005, relative to 1999, are due to the fact that mortgage debts among the young middle-class have substantially increased during this period. For example, from 1999 to 2005, the gain on mortgage debt of middle-class households under age 36 increased by 31.67% from 3.00% to 3.95% under the FS scenario. Under the IA scenario, the gains on mortgage debt of the same group rose from 1.72% to 2.25% of the group's average net worth. For these reasons we find some of the largest increases in gains among the young middle class. For instance, middle-class households under age 36 experience a 58.39% increase in their gains under FS and a 68.15% increase in their gains under IA. Young middle-class households between age 36 and 45 also have a non-negligible increase in their gains between the two benchmark years. In contrast, the youngest poor experience smaller gains in 2005 than in 1999, owing to the decrease in their student loans. Specifically, the poor under age 36 witness a 40.89% reduction in their gains under FS; the figure comes in at around 36.28% under IA. However, over the period 1999–2005 poor households of age 36–45 observe a significant increase in their gains. The increase in the gain of this group comes from the rise in their mortgage debts.

Among households over age 75, losses are mostly greater in 2005 than in 1999, irrespective of income class and inflation scenario. Under IA, the change is pronounced among the elderly rich, whose losses have increased by up to 25% between 1999 and 2005 on account of a shift towards long-term bonds and pensions. A move away from nominal instruments of short maturity also explains why the elderly poor experienced a 45.71% increase in their losses under IA. Whereas in 1999 these positions accounted for only about 18.56% of their average net worth, the figure comes in at around 10.82% in 2005. In general, the trend is towards lower losses for non-retiree net nominal savers (aged 46–65) and higher losses for retirees (age over 66).

5. Comparison to the U.S. economy

In addition to the difference in nominal portfolios over time, differences exist across countries. In this section, we explore how cross-country differences in nominal portfolios between Canada and the United States lead to differences in redistributions. Table 5 compares the sectoral redistributions of the two countries with an inflation episode where inflation exceeds expectations by 5% for 10 years for the benchmark year 2001.[22] The U.S. numbers are from table 2 in Doepke and Schneider (2006).

Under the FS scenario, the government sector receives a windfall gain of 19% of GDP in Canada, compared with 11% in the United States. Under FS, the difference in the extent of redistribution directly comes from the differences in their net nominal position regardless of the term-to-maturity structure of the

22 This is the episode Doepke and Schneider (2006) considered. For comparison purposes, we conduct the same exercise.

TABLE 5
Canada-U.S. comparison of redistributions of wealth as a percentage of GDP, with 5% inflation shock lasting 10 years, 2001 as the benchmark year

Sectors	Government	Foreigners	Households
	Canada		
Full surprise scenario	18.8	−2.8	−16.0
Indexing ASAP scenario	10.6	−1.0	−9.6
	U.S.		
Full surprise scenario	10.8	−7.7	−1.2
Indexing ASAP scenario	3.6	−4.8	1.1

NOTE: The U.S. numbers are from Doepke and Schneider (2006, table 2).

underlying assets. In Canada, the government sector had an NNP of −48.71% of GDP in 2001 relative to a much smaller negative position (less than 40% of GDP) in the United States. On the other hand, foreigners in the United States lose larger values of their assets (−7.7% of GDP) than those in Canada (−2.8%). Finally, we find the largest difference in the household sector. Households in Canada lose 16% of GDP from the inflation scenario, while U.S. households lose only 1.2%. Again, the difference directly comes from the differences in their NNPs. In 2001, Canadian households had a positive position of 41.42% of GDP, whereas their U.S. counterparts had around 10%. Under the IA scenario, relative sizes of redistributions between Canada and the United States are similar to those under FS except for the household sector. The U.S. households gain 1.1% of GDP despite their positive net nominal position because of maturity mismatches between their assets and liabilities.

6. Sensitivity analysis – alternative allocations of business sector's redistribution

Previous discussions assumed that redistributive effects through business sector nominal positions are allocated to other sectors and household groups based on their equity holdings against the business sector. As Harberger (1962) argues, the general equilibrium burden of taxes on businesses would be shared by different parties, for example, equity holders, workers, and consumers. Since an inflation shock, which leads to subsequent redistributions, is a form of tax, Harberger's argument would similarly apply here. Hence, we explore possibilities that workers or consumers receive the indirect redistributions from the changes in the real values of business sector nominal positions. To conduct a clear exercise, we assume that the value of business equities does not change with inflation. Rather, we assume that either workers or consumers, not a mix of them, bear all business sector redistributions. We focus on the baseline inflation episode where inflation exceeds expectations by 1% for five years with 2005 as the benchmark year.

TABLE 6
Redistribution of wealth across households as a percentage of the mean net worth of each age and income class in 2005, with inflation episode of 1% inflation shock lasting five years – labour income as the channel of allocation of business sector redistribution

Age group	<36	36–45	46–55	56–65	66–75	>75
	Full surprise scenario					
All	0.99	0.49	−0.57	−1.10	−1.59	−1.76
Rich	0.14	−0.17	−1.24	−1.40	−1.73	−1.75
Middle-class	1.55	0.86	−0.35	−1.03	−1.58	−1.80
Poor	0.39	0.53	0.18	−0.49	−0.74	−1.29
	Indexing ASAP scenario					
All	0.63	0.23	−0.48	−0.78	−0.90	−0.87
Rich	0.11	−0.16	−0.84	−0.91	−0.91	−0.92
Middle-class	0.97	0.44	−0.39	−0.79	−0.95	−0.85
Poor	0.31	0.36	0.14	−0.15	−0.22	−0.59

6.1. Workers receive indirect redistributive effects

We first assume that workers bear all the indirect redistributions from the business sector, proportionally to their labour income shares. Specifically, as in Meh, Ríos-Rull, and Terajima (2010), we assume the youngest four household cohorts (i.e., age groups from 36 or less to 56–65) to be workers. We use the estimates of household-group wage rates and hours worked discussed in Meh, Ríos-Rull, and Terajima (2010) to construct the relative labour income of twelve household groups (i.e., three income groups times four working age cohorts). Finally, we allocate the business sector redistributions to worker households proportionally to their relative labour income. Table 6 shows the results of this exercise.

Since the business sector always has net negative nominal positions during our data period, working households that receive the business sector redistributions gain over their own direct redistributions; that is, inflation reduces real values of business sector debts. Since non-working households (i.e., cohorts age 66–75 and greater than 75) do not earn labour income, their redistribution numbers in table 6 reflect only those of direct redistribution and hence are lower than those seen in table 3 under both FS and IA. Among workers, since middle-aged (i.e., age 46–65) poor and middle-class households have labour income shares that are higher than their shares of business equities, they also receive higher shares of the benefit of positive business sector redistributions. For example, under FS, age 45–55 middle-class households receive a total redistribution of −0.35% of their net worth when we allocate business sector redistributions through labour income shares. They lose more (−0.55% in table 3) when the allocation of business sector redistributions is based on equity holdings of end users. Other households, the young (age 45 or less) or rich, lose more when we allocate business sector

TABLE 7
Redistribution of wealth across households as a percentage of the mean net worth of each age and income class in 2005, with inflation episode of 1% inflation shock lasting five years – consumption as the channel of allocation of business sector redistribution

Age group	<36	36–45	46–55	56–65	66–75	>75
	Full surprise scenario					
All	1.04	0.52	−0.63	−1.09	−1.19	−1.40
Rich	0.14	−0.18	−1.26	−1.37	−1.51	−1.58
Middle-class	1.69	0.96	−0.41	−1.02	−1.13	−1.40
Poor	0.42	0.59	0.17	−0.59	−0.35	−0.54
	Indexing ASAP scenario					
All	0.66	0.24	−0.53	−0.78	−0.67	−0.68
Rich	0.11	−0.16	−0.85	−0.88	−0.79	−0.83
Middle-class	1.05	0.48	−0.44	−0.78	−0.67	−0.66
Poor	0.33	0.40	0.14	−0.20	−0.07	−0.21

redistributions through labour income shares because their labour income shares are lower relative to their equity shares.

6.2. Consumers receive indirect redistributive effects

Alternatively, we can assume that consumers bear all the indirect redistributions from the business sector. The Canadian Financial Monitor (CFM), in its survey, asked questions regarding household spending for the years 2008 and 2009.[23] Using these consumption data, we construct relative consumption of our 18 household groups. We allocate the business sector redistribution proportional to these relative consumption measures.[24] Table 7 shows the results of this exercise.

Similarly to the discussion in the previous section (i.e., the allocation based on labour income shares), we observe that middled-aged poor and middle-class households benefit more when we allocate business sector redistributions through consumption shares instead of equity shares. In addition, we now observe old (age 66 or older), poor, and middle-class households benefit more with the consumption-share based allocation than they do with the equity-share based one. These households receive higher positive redistributions from businesses because their relative consumption level among households is higher than their relative equity holding level among all end users. For example, under FS, age 75 or older poor households receive a total redistribution of −0.54% of their net worth now compared with −1.14% for the equity-based allocation scheme in table 3.

23 See the technical appendix to the paper for consumption items included in the survey.
24 We are implicitly assuming that household consumption of government services and foreign businesses is proportional to total consumption for all households.

Considering the results of these sensitivity analyses, overall patterns of the magnitude of redistributions change depending on the allocation scheme of the business sector redistributions; however, qualitative results of who gains or loses are similar regardless of the allocation scheme of the business sector redistributions.

7. Conclusion

Motivated by the public debate on monetary policy regimes, we have quantitatively assessed the redistributional effects of inflation in Canada. To do so, we first provided comprehensive documentation of the nominal assets and liabilities of various economic sectors and household groups. Then we conducted an experiment that examined the inflation-induced redistributional consequences of the arrival of a small inflation episode above expectation.

There are three key messages with regard to the inflation-induced redistribution of wealth in Canada. First, we argue that the redistributional effects of inflation are non-trivial and therefore need to be taken into account when different monetary policy regimes are evaluated, since such redistributional effects affect the transition costs of regime changes as well as long-run welfare. The transition costs can be due to the initial nominal portfolios, as agents with different initial portfolios will be affected differently under both regimes. The winners from higher inflation are young middle-class households that are major holders of fixed-rate mortgage debt as well as the government, since inflation reduces the real burden of their debts. The losers are a union of rich households, middle-aged middle-class, and old households that hold long-term bonds and non-indexed pension wealth. Non-indexed pension assets play an important role in the loss of old households.

Second, we show that there has been a shift from short-term nominal instruments to long-term nominal claims over time. We show that partially anticipated inflation generates larger gains or losses for long-term positions than short-term positions. Hence, although Canadians have become less exposed to surprise inflation, since the implementation of the inflation-targeting monetary policy regime, they are still subject to partially anticipated inflation.

Third, we show that the Canadian situation differs from that in the U.S. On one hand, middle-aged middle-class households in Canada are major savers, while their American counterparts are large borrowers. On the other hand, the foreign sector in Canada is relatively small in terms of nominal borrowing and lending and has become, since late 2006, a net borrower. In contrast, foreigners have been major net nominal lenders in the U.S. since the late 1980s. Inflation could entail a potential wealth transfer from Canadian households to foreigners. The comparison of the sectoral redistributions between the two countries shows that even among countries with similar economic and legal environments the redistributional effects of inflation shocks can be quite different.

An important task that is not addressed in this paper is to study the aggregate effects and welfare implications of inflation-induced redistribution under different monetary policy regimes such as inflation and price-level targeting. Since the size of macroeconomic and welfare effects will depend on how the government uses the windfall gains associated with a reduction in the real value of its nominal debts, the analysis also needs to consider different fiscal policy rules. Meh, Ríos-Rull, and Terajima (2010) address this issue and find that, even in the case where the government transfers the windfall gains to households in a lump-sum fashion, redistributional effects of inflation can lead to sizeable welfare changes in some households.

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