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Kan'ei Tsuho: Japan's Immutable Coinage

Paul Berry, Chief Curator, Currency Museum

In its efforts to consolidate power in the early seventeenth century, the Tokugawa shogunate standardized Japan's coinage. One coin, in particular, is closely identified with this period in Japanese history. First issued in 1636, in the era of Kan'ei, meaning "generosity everlasting," the new coins replaced a mixture of Chinese copper coins and Japanese copies of varying, and often poor quality, called *bita sen*, that were used for small, everyday transactions. The new coins, or *mon*, were produced in various forms for almost 250 years but carried essentially the same design, based on the name of the era in which they were first minted.

Early issues were cast in bronze and were about 26 mm in diameter. The design consisted of a circular frame containing the legend "Kan'ei Tsuho": four *kanji* characters (Japanese writing using Chinese characters) arranged around a central hole used for stringing the coins. The legend, meaning "generosity everlasting current money," was read from top to bottom and right to left. As later issues of different denominations were released from different mints and in different metals, the design remained unchanged. Cast in Edo (ancient Tokyo), Osaka, and other locations in Japan, these issues can be distinguished from one another only by the style of their calligraphy. So popular were the coins that money changers used the image on signs advertising their business.

In 1668, the government issued a distinctive piece cast from the metal of a great statue of Buddha that had been destroyed in an earthquake. These coins are distinguished from other issues by the character "bun" (文) on the reverse, designating the era of Kanbun (1661–73) when they were issued. As late as the early twentieth century, long after they had ceased to serve as currency, people hoarded these coins, believing that they contained a small amount of the gold said to have clad the statue. Recent studies have shown that they contain no gold.

In the early eighteenth century, as Japan's copper supply dwindled, lighter coins as small as 20 mm in diameter were issued. Official mints began marking the coins to identify their products, and several unofficial mints cast coins to meet local needs. The design, with its four *kanji* characters, remained unaltered, however. Later, the government began casting the coins in iron. These pieces were not as attractive: the castings were coarse, and the metal quickly rusted. Nevertheless, the coins circulated in ever-increasing quantities, until the mid-nineteenth century, when they were withdrawn by the new Meiji government as part of an overhaul of the monetary system.

The coins pictured on the cover are part of the National Currency Collection.

Photography by Gord Carter, Ottawa.

Contents

Articles

- 1 Declining Inflation Persistence in Canada: Causes and Consequences**
- 15 The Evolution of Capital Flows to Emerging-Market Economies**
- 29 Making Bank Notes Accessible for Canadians Living with Blindness or Low Vision**

-
- 37 Bank of Canada Publications**
-

Declining Inflation Persistence in Canada: Causes and Consequences

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- *The persistence of both core and headline CPI inflation in Canada has declined significantly relative to the 1980s.*
- *The adoption of explicit inflation targets in 1991 likely played a key role in this decline. The impact of more activist monetary policy and lower variance of long-run inflation expectations on wage- and price-setting behaviour appears to have been particularly important. This suggests that the degree of structural inflation persistence is low in Canada.*
- *The degree of structural inflation persistence has important implications for the speed with which inflation should be returned to target, the degree to which policy should be forward looking, and the relative merits of inflation- and price-level targeting. Other things being equal, price-level targeting is more effective as a stabilization tool when structural inflation persistence is low.*

Longworth (2002) documents changes to the dynamic properties of several key macro-economic variables in Canada that occurred around the beginning of the 1990s. Noteworthy among these changes is a reduction in the level, variance, and persistence of various measures of price inflation, including the consumer price index (CPI). While each change is significant in its own right, the focus of this article is on the reduction in inflation persistence, defined here as the correlation between current and lagged inflation. In addition to updating certain estimates of inflation persistence, the article examines possible reasons for the decline that have been suggested in the economics literature. In particular, a distinction is drawn between the role played by monetary policy, through its effect on price- and wage-setting behaviour, and possible changes to the structure of the economy that are independent of monetary policy, including the distribution of shocks. Finally, a normative analysis of the desirability of low inflation persistence is provided from the viewpoints of an inflation-targeting (IT) and a price-level-targeting (PLT) central bank.

At first glance, it may seem surprising that the Bank of Canada should be concerned about inflation persistence or its causes. After all, the Bank's mandate is to maintain the level of inflation close to the midpoint of the target range. The extent and causes of inflation persistence can be very important, however, in determining the optimal way to achieve the Bank's current mandate of inflation control.

By definition, a variable that is persistent responds more sluggishly in the short run, other things being equal. This is analogous to the difference in manoeuvrability between a speedboat and an ocean liner. Since an ocean liner has a great deal of momentum because of its enormous mass, there is a considerable lag before changes to its intended path are fully reflected in its actual path. For a central bank that

regards inflation as highly inertial for reasons unrelated to the conduct of monetary policy, that policy must be set based on a projection of where inflation will be in the future, rather than on its current level. This is precisely because policy actions will have their maximum impact on inflation several periods after the action is initiated.

Inflation persistence, as well as its underlying causes, is relevant not only to the Bank's achievement of its current inflation target; it is also very significant for determining what the ideal target should be. Since the Bank is currently exploring the potential benefits of replacing its current inflation target with a target for the price level, the issue is of particular interest.

Finally, inflation persistence is relevant not only for central banks. If prices and wages (or any other contract specified in nominal terms) are adjusted only periodically, then knowing the degree of inflation persistence is relevant when deciding the best price or wage to set, when given the opportunity to do so. For instance, if inflation has recently been high and is known to be persistent, households will negotiate a higher nominal wage, since high inflation is likely to persist into the future, eroding the real purchasing power of their wage through time. This can create a vicious circle, whereby persistence tends to beget even greater persistence because of the important role played by expectations. In this example, higher wages raise firms' costs, which will be partly reflected in higher prices. Therefore, price inflation in the future will be higher for longer.

This article begins with a comparison of persistence estimates for total and core CPI inflation for the periods 1980–90 and 1991–2009. Possible explanations for the observed decline are then reviewed, including changes to the structure of the economy, changes in the distribution of shocks, and the establishment of a credible inflation target by the Bank of Canada in 1991. The implications of low inflation persistence for the conduct of monetary policy are then considered for both inflation-targeting and price-level-targeting regimes.

Revisiting Estimates of Inflation Persistence

Longworth (2002) focuses on changes to the persistence of inflation between the 1980s and 1990s. This is a natural division, given that the Bank of Canada adopted an explicit target for inflation at the beginning

of the 1990s.¹ In addition to theoretical arguments linking the conduct of policy to the behaviour of inflation, formal statistical tests tend to support the early 1990s as the period in which the changes began to occur.²

Table 1 summarizes changes in the estimated degree of persistence for total and core CPI inflation, and both series are plotted in **Chart 1**. Persistence is estimated for both the year-over-year change and the quarterly change in each price index.³ For quarterly (year-over-year) inflation, persistence is defined by the correlation between current inflation and inflation lagged one (four) quarter(s). The key message is that the degree of persistence displayed by both core and headline CPI inflation has declined significantly, relative to the 1980s. These results are qualitatively similar to recent estimates in Benati (2008) and Levin, Natalucci, and Piger (2004).⁴ Benati (2008), in particular, emphasizes that quarterly inflation in Canada now appears to display no persistence whatsoever. This means that, on average, the current-period rate of inflation is uninformative for predicting the rate of inflation in the next period.

Why Has Persistence Declined?

Sources of inflation persistence

A natural starting point for discussing inflation dynamics is the price Phillips curve, which generally models inflation as a function of lagged inflation, one or more relative prices, and a measure of capacity pressures, such as the unemployment or output gap. In recent years, one particular variant of this model, referred to as the New Keynesian Phillips curve (NKPC) has taken on particular prominence at central banks and among academics, primarily because it can be rationalized

- ¹ In February 1991, the Bank of Canada (in a joint statement with the Minister of Finance) announced the introduction of an inflation-reduction target. The period between 1982 and 1990 has been labelled *the search for a new nominal anchor*, since the Bank determined in 1982 that it would no longer target M1 (Thiessen 2000).
- ² Qualitatively similar declines in persistence have been observed for other countries that adopted inflation targeting. Benati (2008) presents recent evidence for the United Kingdom, Sweden, Switzerland, New Zealand, and the euro area under the European Monetary Union.
- ³ We use quarterly data to facilitate comparison with the artificial data generated by ToTEM (discussed in the next section). Statistics reported in Longworth (2002) are based on monthly data.
- ⁴ Benati (2008) reports an estimate of -0.3 for the sum of the autoregressive parameters of an AR(p) model, whereas Levin, Natalucci, and Piger (2004) report -0.2 for the largest autoregressive root, both for the IT sample. Negative estimates may be due to an apparent negative fourth-order partial correlation in the seasonally adjusted CPI data.

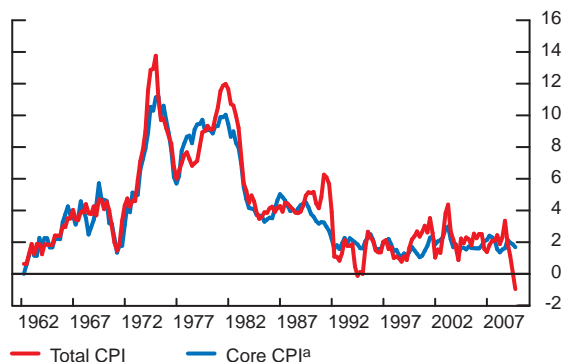
Table 1: Correlation between current and past inflation

Inflation measure	1981Q1 to 1990Q4	1991Q1 to 2009Q3
Total CPI		
Quarterly change ^a Corr. (π_t, π_{t-1})	0.80 ^b	0.14
Year-over-year change Corr. (π_t, π_{t-4})	0.79 ^b	-0.13
Core CPI		
Quarterly change ^a Corr. (π_t, π_{t-1})	0.82 ^b	0.05
Year-over-year change Corr. (π_t, π_{t-4})	0.77 ^b	-0.04

- a. Quarterly inflation is defined as $\pi_t = \ln(P_t/P_{t-1})$, whereas year-over-year is defined as $\pi_t = \ln(P_t/P_{t-4})$.
- b. Indicates that the point estimate is significantly different from zero at the 1-per-cent level.

Chart 1: Consumer price index

Year-over-year percentage change, quarterly data



- a. CPI excluding eight of the most volatile components and the effect of changes in indirect taxes on the remaining components
- Source: Bank of Canada

on the basis of microeconomic theory.⁵ A generic form of the NKPC is given as:

$$\pi_t = (1 - \alpha_1)\pi_t^* + \alpha_1\pi_{t-1} + \alpha_2 E_t \sum_{i=0}^{\infty} \alpha_3^i mc_{t+i} + \varepsilon_t, \quad (1)$$

where π_t is the quarterly rate of inflation, π_{t-1} is the rate of inflation from the previous quarter, π_t^* is the inflation rate expected to prevail in the distant future,⁶

- 5 The extent to which the fixed-parameter version of the NKPC can be considered micro-founded is somewhat controversial, since, among other things, the most widely used version is based on the assumption that firms do not make a rational choice to adjust their price. Rather, firms are chosen according to a lottery system that ignores how long their nominal price has been in effect.
- 6 Strictly speaking, the NKPC derived under the assumption of positive steady-state inflation contains several additional terms (Ascari 2004). These are not very important for explaining inflation in the NKPC, however, and are omitted for simplicity.

mc_{t+i} is the real marginal cost⁷ of production i periods in the future relative to the average level or steady state, and ε_t is a random shock term. The latter term is often interpreted as capturing movements in firms' desired markup of price over nominal marginal cost, and we also adopt this interpretation. α_1 , α_2 , and α_3 are non-negative parameters, which are normally treated as fixed through time.

The key assumption underlying this NKPC is that individual firms do not change prices every period, but that, when given the opportunity to do so, a positive proportion of firms rationally choose a price that maximizes their expected profits.⁸ Since it is known that the chosen price will remain in effect for several periods, account is taken of both current and expected *future* marginal cost, meaning that inflation is a forward-looking variable. The remaining firms are assumed to follow a simple rule of thumb (ROT), such as choosing the average price in the previous period, adjusted by the previous period's inflation rate.

From equation (1), there are four potential sources of persistence: the long-run-expectations channel (LRE), captured by π_t^* ; expectations of current and future marginal cost (short-run-expectations channel (SRE)); the lagged inflation term; and the desired markup. In general, the persistence, variance, and co-movement among these variables, along with the numerical values for α_1 , α_2 , and α_3 , will determine the persistence of inflation.

The LRE channel can be interpreted as agents' perception at time t of the rate of inflation to which the economy would eventually converge in the absence of future shocks. If constant through time, the LRE will not be a source of persistence. Given the historical variation in the rate of inflation in Canada (Chart 1) since the beginning of the 1980s, however, it seems reasonable to assume that π_t^* has varied somewhat

- 7 Real marginal cost refers to the cost incurred by the firm of producing an additional unit of output, divided by the price that it receives for that output. Under certain circumstances, marginal cost is proportional to average cost.
- 8 The NKPC employed here follows Galí and Gertler (1999), which is an extension of the model proposed by Calvo (1983). The Calvo (1983) specification obtains when $\alpha_1 = 0$. A similar means for obtaining lagged inflation in the NKPC has been proposed by Christiano, Eichenbaum, and Evans (2005) and generalized by Smets and Wouters (2007). In these versions, all firms set prices rationally when selected to reset. Firms not chosen in a given period can, nevertheless, index their price according to the lagged rate of price inflation. These models are founded more on the premise that the cost of simply changing one's price (i.e., pure menu costs) is small, but the cost of choosing a new price optimally is not, which explains why firms change price every period but re-optimize only periodically. This model of firm behaviour has been criticized because it makes the counterfactual prediction that all prices change every period (Chari, Kehoe, and McGrattan 2009).

through time. Moreover, since firms are not likely to revise their estimate of the long-run inflation rate significantly from one period to the next, this variable will display low variance and high persistence, and this persistence will be transmitted to actual inflation through the Phillips curve.

All shocks except changes to the desired markup are transmitted to inflation via their influence on marginal cost (relative to steady state). The overall persistence of marginal cost will depend on the composition of shocks in the economy, the degree to which the economy can adjust to the shock (including the degree of price and wage flexibility), and as will be discussed in the next section, the conduct of monetary policy.

When ROT price setters are present in the economy, parameter α_1 will be positive, and current inflation will be influenced by lagged inflation. The value of this parameter is increasing, both in the share of ROT price setters and in the weight on lagged inflation used in the rule of thumb.⁹

For the remainder of the article, we use the term *structural* or *intrinsic* to refer to persistence that comes about via the inclusion of lagged inflation in equation (1) when α_1 is positive, as well as to any persistence inherent in the desired markup, ε_t . It is worth noting that our definition of structural does not correspond to the more common policy-invariance property first introduced by Lucas (1976), since we will discuss various ways in which the conduct of policy can influence α_1 .

Potential causes of reduced persistence

Changes to the conduct of monetary policy

The previous section identifies four possible sources of inflation persistence. Given that the decline in persistence in Canada appears to have roughly coincided with the Bank of Canada's adoption of an inflation target in 1991, a natural starting point is discussion of the possible channels through which a change in monetary-policy regime might influence these variables.

⁹ In Galí and Gertler (1999), the weight on lagged inflation is set to one; i.e., there is full indexation. Amano, Mendes, and Murchison (2009) develop a model where the rule of thumb is $p_t = p_{t-1}^* (1 + \pi_{t-1})^\gamma \mu_t$, where p_{t-1}^* is the average price chosen in the preceding period, γ is the indexation parameter, which can take on any value between 0 and 1, and μ_t is the desired (gross) markup.

The decline in persistence in Canada appears to have roughly coincided with the Bank of Canada's adoption of an inflation target in 1991.

The first channel is through private agents' long-run expectations for inflation, which should converge to the inflation target once the credibility of the regime has been clearly established. As the variance of π_t^* declines, so will the persistence of inflation, since it will account for a smaller proportion of the overall variance in the level of inflation. Monetary policy can potentially influence π_t^* in two ways. First, if long-run expectations are partially influenced by the shocks that govern short-run expectations, then policies that stabilize the latter will help to stabilize the former.¹⁰ Second, to the extent that a central bank can demonstrate a commitment to a policy rule that is sufficiently aggressive to eventually return inflation to the target, long-run expectations should be stable, even if short-run expectations respond to shocks.¹¹ Persistent deviations from the rule, on the other hand, can send a signal to private agents that the central bank's long-run inflation objective has changed.

There are three main ways of inferring long-run inflation expectations, which are not directly observable. The first involves surveys of long-horizon inflation forecasts. Both the 2-year-ahead survey prepared by the Conference Board of Canada and the 6-to-10-year-ahead survey prepared by Consensus Economics suggest that long-run inflation expectations in Canada have become less volatile since the adoption of IT, and are now essentially decoupled from current economic developments. This conclusion is supported by more formal econometric evidence presented in Levin, Natalucci, and Piger (2004). The authors analyze the relationship between long-horizon inflation expectations (proxied by private sector forecasts) and current inflation for a panel of IT and non-IT countries, including Canada, and

¹⁰ In the limiting case, where either $\pi_t^* = \pi_t$ or $\pi_t^* = \pi_{t-1}$, the weight on lagged inflation increases to one, and inflation becomes very persistent.

¹¹ A related strand of the literature assesses the role played by sticky long-run inflation expectations in disinflations. Erceg and Levin (2003) show that the inclusion of a perceived objective for long-run inflation, which can differ from the actual central bank objective because of imperfect credibility, can explain both the persistence of inflation and the large output costs, following a deliberate disinflation by the monetary authority. An illustration of this approach for Canada can be found in Murchison and Rennison (2006, 76).

conclude that there is no link for the IT countries from 1994 to 2003, whereas there is a positive relationship for the non-IT countries.

The second approach involves inferring long-run inflation expectations from differences between long-term nominal and real interest rates, which we will refer to as the inflation premium. Gürkaynak et al. (2006) examine the reaction of both long-term nominal interest rates and the inflation premium to unanticipated macroeconomic news in Canada and conclude that neither systematically responded from 1998 to 2005.¹² Finally, Amano and Murchison (2006) estimate the perceived level of long-run inflation for Canada using an unobserved-components model developed by Kozicki and Tinsley (1998, 2002). Their estimate suggests that the variance of long-run expectations declined by about half in the 1990s, relative to the 1980s.

Monetary policy can influence inflation persistence via its effect on both the variance and the persistence of real marginal cost.

Monetary policy can also influence inflation persistence via its effect on both the variance and the persistence of real marginal cost (SRE channel). From equation (1) it can be seen that current inflation depends on current and expected future real marginal cost. Therefore, if the persistence of marginal cost declines, other things being equal, so will the persistence of inflation. Taylor (2000) argues that moving from a high- to a low-inflation environment has reduced the expected persistence of changes in marginal cost and, consequently, the degree of pass-through to prices. Murchison (2009) extends Taylor's argument, suggesting that this change in persistence may be due to a change in the parameters of the central bank's policy rule.¹³ In the case of Canada, if monetary policy began responding more aggressively to economic developments that threaten to push inflation away from the target, the expected persistence of real marginal cost and inflation should decline.

¹² Owing to data limitations, the authors do not compare the pre- and post-IT behaviour of inflation expectations in Canada.

¹³ Carlstrom, Fuerst, and Paustian (2009) study the link between policy aggressiveness, the relative variance of technology shocks, and inflation persistence in an NKPC for the United States.

To understand the link between the *variance* of marginal cost and inflation persistence, we must first recall that the NKPC distinguishes between shocks that are transmitted to inflation through marginal cost, including demand and productivity shocks, and shocks to firms' desired markup of price over marginal cost, ε_t . Since there is no particular reason to think that the persistence of marginal cost and the desired markup should be identical, their contribution to inflation persistence will depend on their relative variance. The intuition for this is straightforward; for example, if all of the variance in inflation were driven by marginal cost, only the persistence of marginal cost would matter. In this way, the variances of each variable are like weights that determine their influence on the properties of inflation. Since measures of real marginal cost are usually found to be much more persistent than the desired markup, a decline in the variance of marginal cost relative to ε_t will reduce inflation persistence.¹⁴

Provided that the variance of markup shocks is not too high, a more aggressive policy rule will also reduce the variance of output and marginal cost.¹⁵ For instance, since marginal cost is heavily influenced by wages, its response to a shock will depend importantly on the size of the wage reaction. If households expect monetary policy to respond aggressively to keep inflation close to the target, then the desired change in nominal wage and marginal cost will be smaller.

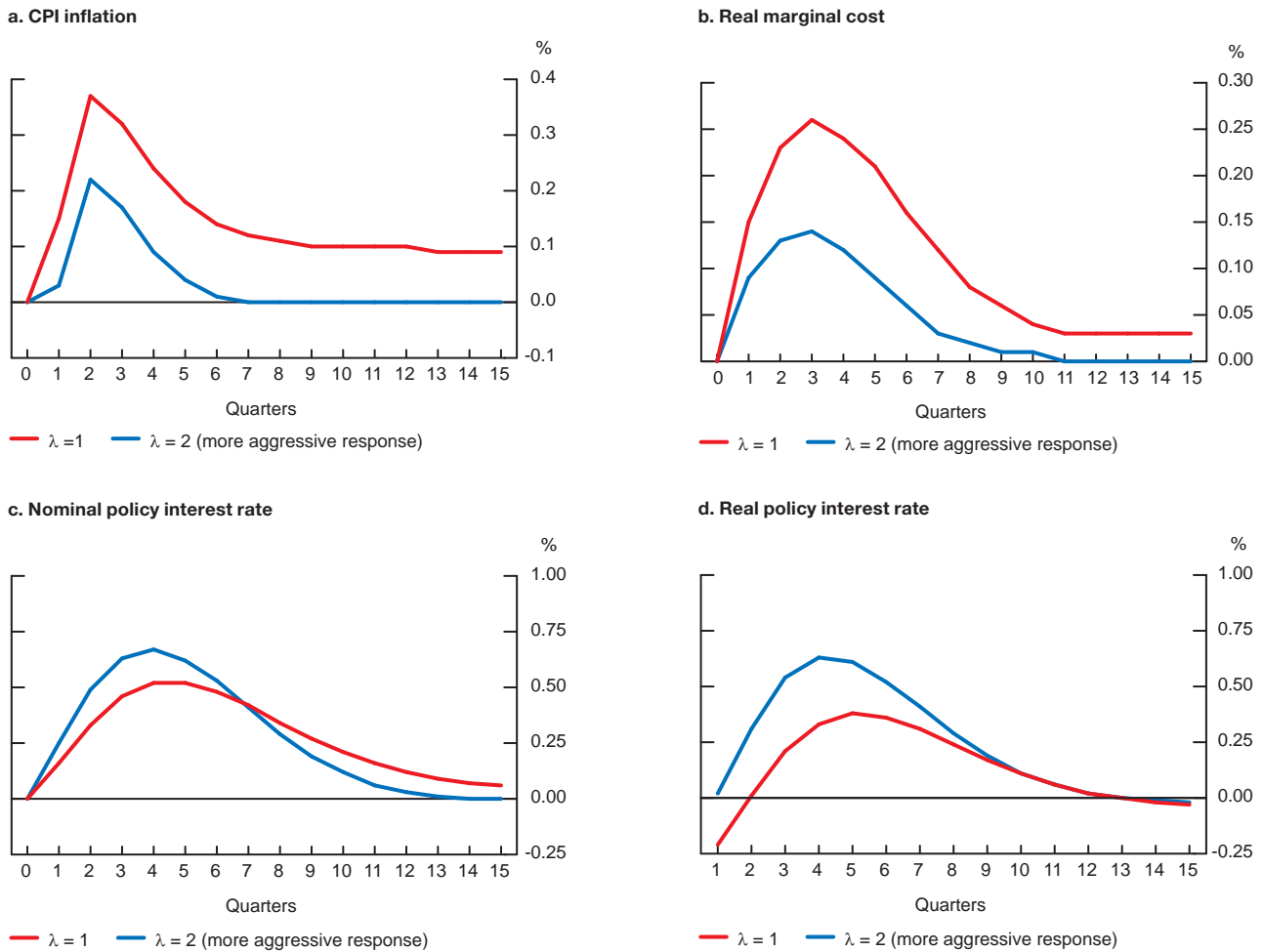
A hypothetical example of the persistence and variance channels for monetary policy is shown in **Chart 2**. The Bank of Canada's main projection model for Canada, ToTEM, is used to simulate the reaction of marginal cost and quarterly (at annual rates) CPI inflation to an unanticipated increase of 1 per cent in foreign aggregate demand, under two different calibrations of a simple monetary-policy rule given by:

$$R_t = \rho R_{t-1} + (1 - \rho) \left[R^* + \lambda \left(\varphi_\pi (E_t \pi_{t+k} - \pi^T) + \varphi_y (ygap_t) \right) \right], \quad (2)$$

¹⁴ The first-order autocorrelation coefficient for the discounted sum of future marginal costs in ToTEM from 1981Q1 to 2009Q3 is 0.93, whereas the equivalent coefficient for the desired markup is just 0.27.

¹⁵ When faced with a markup shock, monetary policy stabilizes inflation through its influence on marginal cost, making monetary policy a source of variance in marginal cost. As a result, if inflation is predominantly driven by markup shocks, or if the central bank is concerned mainly with stabilizing inflation, increasing the aggressiveness of the policy response could increase the variance of marginal cost.

Chart 2: Results of different policy responses to a foreign-demand shock of 1 per cent in ToTEM



Source: Bank of Canada

where R_t is the policy interest rate in period t , R^* is the long-run steady-state level of interest rates, $E_t \pi_{t+k}$ is the period t expectation of inflation in period $t+k$, π^T is the inflation target, and $ygap_t$ is the output gap. ρ , φ_π , and φ_y are fixed parameters that determine the degree of interest rate smoothing and the sensitivity of the policy rate to deviations of inflation from target and to the output gap, respectively.¹⁶ Note that k determines the degree to which policy is forward looking and is referred to as the “feedback horizon.”

In the first scenario, the parameter λ , whose value influences proportionately the policy response to inflation and to the output gap, is set to one. In the second scenario, $\lambda = 2$, meaning that the central

bank adjusts the policy interest rate by twice as much in response to a given level of expected inflation or of the output gap, relative to the first scenario.

An increase in foreign real GDP generates an increase in demand for Canadian exports and a depreciation of the exchange rate, both of which put upward pressure on inflation and the output gap. In the first scenario, the policy interest rate is increased by a maximum of about 50 basis points by the end of the first year. In the second scenario, the rate increases faster and by more, so that the increase is almost 70 basis points after one year. Overall, the nominal interest rate is higher in the second scenario for the first two years. For a given expected rate of inflation, a higher nominal interest rate will translate into a higher *real* rate, which acts to temper the rise in domestic demand and inflation in Canada. Thus, a virtuous circle is created

¹⁶ The values $\varphi_\pi = 1.1$, $\varphi_y = 0.6$, and $k = 0$ are taken from Murchison (2009).

in the second scenario, whereby lower expected inflation generates a higher real interest rate, which puts additional downward pressure on inflation.

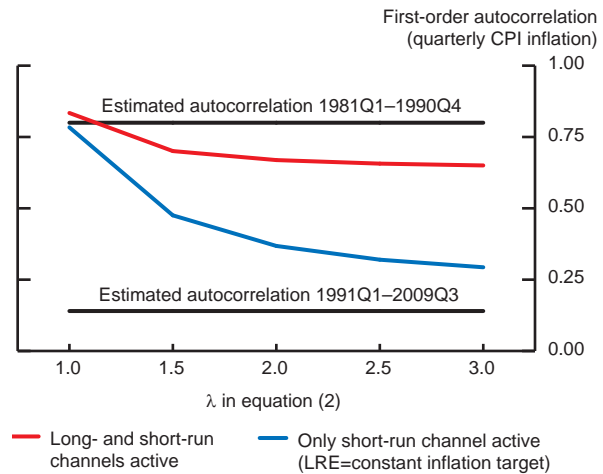
The difference in the magnitude of the policy response explains the smaller increase in marginal cost (reduced variance) and the faster return to its pre-shock level (slightly reduced persistence). Since the discounted sum of future marginal costs is reduced, the peak response of inflation is nearly cut in half, and inflation is back to its pre-shock level in two years, whereas inflation remains above the target for several years in the first scenario.

To roughly quantify the link between the two expectations channels (LRE and SRE) and the conduct of monetary policy, ToTEM is again used to simulate the level of inflation persistence for different calibrations of the monetary policy rule described by equation (2). The horizontal axis in **Chart 3** gives the coefficient λ , which ranges from 1.0 to 3.0, in the monetary policy rule. The lowest value corresponds to the value estimated in Murchison (2009) for the 1970–83 period, and is similar to the rule presented in Gagnon and Ihrig (2001).¹⁷

Chart 3 shows a modestly negative relationship between the aggressiveness of monetary policy and inflation persistence when the variance of long-run inflation expectations, π_t^* , is set equal to its historical value from 1981 to 1990.¹⁸ When the LRE channel is active and monetary policy is largely passive (far left), ToTEM matches the persistence of quarterly inflation over the 1981–90 period (0.8) quite closely. As policy becomes more aggressive, the persistence of marginal cost (via the SRE channel) declines, and the overall persistence of inflation declines by a moderate amount. When long-run expectations are not well anchored, however, the extent to which policy can reduce persistence through the SRE channel is quite limited.

When the variance of π_t^* is set to zero, which is a reasonable depiction of long-run inflation expectations since the establishment of a credible inflation target in Canada, the negative relationship between policy aggressiveness and persistence is much more pronounced. Estimated policy rules are subject to considerable parameter uncertainty, but based on Lam and Tkacz (2004), we judge a value of 2 for λ to be a reasonable calibration for the 1990s. If we further

Chart 3: Inflation persistence and monetary policy in ToTEM



Source: Bank of Canada

assume that this value has not changed significantly since 2000, then ToTEM predicts that the persistence of inflation should have declined from about 0.8 in the 1980s to about 0.35 since 1991.

To summarize, ToTEM ascribes an important role to more activist monetary policy and a somewhat smaller role to reduced variability in long-run inflation expectations. The influence of monetary policy via both the long-run and short-run expectations channels explains the majority of the decline in inflation persistence in ToTEM, suggesting that high inflation persistence is not intrinsic to the Canadian economy. This result is consistent with Benati (2008), who obtains an estimate of $\alpha_1 = 0.19$ for Canada over the IT period. Nevertheless, the full extent of the decline in overall persistence cannot be explained by changes to the behaviour of LRE and SRE alone in ToTEM, since the point estimate for quarterly CPI inflation for the 1991–2009 sample is 0.14, whereas ToTEM predicts a value close to 0.35 when $\lambda = 2$. This suggests that other factors may have contributed to the decline. We next examine possible links between monetary policy and the parameters of the NKPC in equation (1).

The coefficients of the NKPC are typically assumed to be invariant to the conduct of monetary policy. But major regime changes, such as the adoption of an inflation target, may cause these parameters to change, which will influence inflation persistence. The direction of the change is not clear, however, since there are potentially offsetting effects. For instance, Dotsey, King, and Wolman (1999) argue that the move from an environment of high to low trend inflation will

¹⁷ We are aware of no estimated policy rules for Canada over the 1981–90 period.

¹⁸ The calibration of π_t^* in ToTEM is discussed in Murchison and Rennison (2006, 48). Movements in long-run expectations are driven by persistent deviations from the policy rule.

lead firms to change prices less frequently. The intuition for this result is quite simple: in a world with positive trend inflation and sticky prices, firms can no longer achieve their desired relative price each period because inflation causes it to decline through time.¹⁹ The higher the rate of trend inflation, the larger is the average difference between optimal and actual relative prices, meaning larger forgone profits for firms. Therefore, firms will have an incentive to change prices more frequently in a high-inflation environment and less frequently when inflation is low.²⁰

When prices become stickier, the parameter α_2 in equation (1) declines, and, hence, price inflation responds more slowly to differences between nominal marginal cost and the price level (real marginal cost). As a result, the gap takes longer to close, meaning that real marginal cost becomes more persistent. To summarize, to the extent that low and stable inflation leads to greater nominal rigidity in goods and labour markets, inflation will tend to become more persistent, other things being equal.

A similar argument can be made for the labour market. As wages become stickier, a firm's marginal cost will tend to become more persistent, since wages are an important component of overall costs. However, stickier wages will also tend to reduce the variance of marginal cost. Therefore, the overall impact of inflation persistence will depend on which of these offsetting effects dominates.

In contrast, Minford (2004), Minford, Nowell, and Webb (2003), and more recently, Amano, Ambler, and Ireland (forthcoming) study a labour market in which households that do not re-optimize their wage in a given period can still index their nominal wage to the previous period's rate of inflation. This form of indexation is intended to loosely mimic so-called cost-of-living-adjustment (COLA) clauses, and acts as imperfect insurance against unanticipated shocks that affect households' real wage. The authors find that in an environment of lower inflation variance and persistence, households find it optimal to reduce the extent of indexation. Equivalently, this means that a lower proportion of households find it optimal to have wage indexation built into their labour contract. While the focus of these papers is on the benefits of PLT compared with IT, the basic argument would appear to hold generally for policy regimes that produce greater economic stability.

¹⁹ Assuming that prices are not indexed to steady-state inflation each quarter.

²⁰ Provided that the cost of changing prices does not depend importantly on the trend rate of inflation.

In an environment of lower inflation variance and persistence, households find it optimal to reduce the extent of indexation.

To summarize, research using theoretical models predicts that monetary regimes that reduce the level and variance of inflation will result in an increase to the average duration of nominal price and wage contracts and a decrease in the rate at which households index wages to lagged inflation. Labour market data from Human Resources Development Canada support both of these predictions for Canada. For instance, the average life of private sector wage settlements was 28 months over the 1981–90 period and rose to 39 months for the period 1995 to 2009, while the average share of private sector wage settlements with COLA clauses declined from 31 per cent to 20 per cent for the same sample periods. Other things being equal, longer nominal price contracts will tend to make inflation more persistent, while a reduction in nominal wage indexation will have the opposite effect, and the effect of longer wage contracts is ambiguous.

Causes unrelated to monetary policy

While the move to a transparent, easily understood, and credible target for monetary policy in Canada no doubt played an important role in the decline of inflation persistence, other plausible explanations have been suggested in the literature; most notably, the *structural change* and the *good luck* arguments. While typically employed to explain the so-called Great Moderation, elements of these arguments also apply to the issue of inflation persistence.²¹ This stems from the fact that a reduction to the variance of real marginal cost will reduce inflation persistence.

A reduction to the variance of real marginal cost will reduce inflation persistence.

²¹ The term “Great Moderation” dates back to work by Kim and Nelson (1999), McConnell and Perez-Quiros (2000), and Stock and Watson (2003a), which together document a decline in the variance of inflation and output growth in the United States. Although the timing of the declines differs somewhat, similar reductions in variance have been observed for several other countries, including Canada (Longworth 2002).

McConnell and Perez-Quiros (2000), among others, argue that structural change, primarily in the form of improvements to inventory-management technology, reduced the variance of inventory investment, and hence, of output growth in the United States, beginning around 1984. For Canada, however, the evidence is less clear cut. The decline in the variance of output growth, which does coincide roughly with the decline in inflation persistence (Debs 2001), appears to have been driven by a combination of lower variance in the growth rate of goods consumption and of residential investment, which is more difficult to link directly to structural change. The role played by inventory investment appears to be less important (Debs 2001), and where evidence of a break has been found (Liu and Painchaud 2002), the timing of the change (1983) does not coincide with reduced inflation persistence.

The good luck argument is based on the notion that the variance of adverse shocks has declined, and as a result, the variance of endogenous variables, such as output growth and inflation, has also declined. To apply the good luck argument to the issue of inflation persistence, it must be true that the relative variance of those shocks that cause persistent inflation movements has declined. Carlstrom, Fuerst, and Paustian (2009) use a New Keynesian model, similar to that given by equation (1), to demonstrate that a reduction in the relative variance of technology shocks, which are transmitted to inflation through real marginal cost, could explain reduced inflation persistence. They also present evidence for the United States that indicates a reduction to the relative variance of technology shocks.

More generally, several authors have presented VAR-based evidence of a structural break in shock variances for the United States that coincides with the Great Moderation.²² The difficulty with the good luck argument is that a structural break in the behaviour of monetary policy may itself explain the decline in these variances. If the model does not correctly control for other changes, such as the behaviour of the central bank's policy rule, they will show up in the model's error terms. This point is developed extensively in Benati and Surico (2009), who show that structural VAR-based methods will tend to indicate a spurious reduction in shock variances, even when the only change to the underlying structural model is an increase in the responsiveness of monetary policy to inflation fluctuations.

²² See Stock and Watson (2003b), Primiceri (2005), Sims and Zha (2006), Gambetti, Pappa, and Canova (2008).

Implications for the Conduct of Monetary Policy in Canada

Low structural persistence in inflation has potentially important implications for the conduct of monetary policy. For example, Levin and Williams (2003) show that the performance of monetary policy rules can be very sensitive to the level of structural inflation persistence. Similarly, Walsh (2003) demonstrates that targeting the price level yields benefits only if the degree of inflation persistence is sufficiently low. These authors provide examples of a general principle: the degree of persistence in structural inflation should be a key factor in the design of monetary policy.

Of particular interest are the implications of low inflation persistence for inflation-targeting (IT) and price-level-targeting (PLT) regimes. When monetary policy targets inflation, changes in structural persistence can have implications for the optimal speed with which inflation should be returned to target, as well as the degree to which policy should be forward looking. Inflation persistence can also alter the relative merits of IT and PLT. However, it is important to consider that structural inflation persistence, as we define it, can also be policy-regime dependent. In particular, behavioural changes could lead to higher structural persistence in inflation under PLT than under IT.

Inflation targeting

Canada adopted an IT regime in February 1991. When inflation deviates from 2 per cent, the Bank of Canada aims to return it to target within 18 to 24 months.²³ This is known as the “inflation-target horizon.”²⁴

Low structural inflation persistence implies a shorter optimal target horizon.²⁵ Consider the optimal response to a positive markup shock in the NKPC. If the central bank cares about variance in both inflation and the output gap, it will choose to offset only part of the shock's impact on inflation by reducing aggregate demand and marginal cost. As the weight on lagged

²³ The policy of bringing inflation back to target within a horizon of 18 to 24 months is generally appropriate, although specific occasions may arise in which a somewhat shorter or longer time horizon might be considered. For example, Basant Rai and Mendes (2007) demonstrate that, in the face of a large and persistent asset-price shock, it may be appropriate to take a somewhat longer view of the inflation-target horizon.

²⁴ For an overview of issues related to the Bank's inflation-target horizon see Coletti, Selody, and Wilkins (2006).

²⁵ Batini and Nelson (2001) introduce and formalize the concept of an optimal target horizon.

inflation declines, the cumulative loss in output required to comply with a given target horizon will diminish. That is, less movement in output is required to stabilize inflation when persistence is lower. Thus, reduced persistence implies that the central bank can return inflation to target more quickly without incurring the cost of additional variance in the output gap. This, in turn, implies that the optimal target horizon shortens as the degree of structural inflation persistence declines.

*Low structural inflation persistence
implies a shorter optimal
target horizon.*

More formally, Steinsson (2003) shows that, as the proportion of forward-looking firms increases, it becomes optimal to undo a greater fraction of the impact of shocks on the long-run price level. Recall that, under inflation targeting, a central bank stabilizes the rate of change of prices (inflation), but not the level of prices. This implies that shocks that move inflation away from target temporarily will have a permanent effect on the price level (known as price-level drift). Steinsson finds that greater forward-looking behaviour, and thus decreased inflation persistence, is associated with lower optimal price-level drift.

Amano, Mendes, and Murchison (forthcoming) decompose the sources of optimal price-level drift. They note that a reduction in the number of rule-of-thumb (ROT) firms has two effects on the NKPC: (i) it decreases the weight on lagged inflation (α_1), and (ii) it increases the weight on future demand conditions (α_2 and α_3). Both of these changes serve to make inflation more responsive to demand conditions. Thus, when there are fewer ROT firms in the economy, monetary policy can return inflation to target, following a markup shock, with less disruption to the real economy.

Similarly, a reduction in the weight of lagged inflation in the ROT reduces the influence of lagged inflation in the NKPC. Since lagged inflation cannot be influenced by current policy, a reduction in the coefficient on lagged inflation enhances the ability of monetary policy to simultaneously stabilize inflation and aggregate demand.²⁶

Inflation persistence also has an important impact on the degree to which monetary policy should be forward looking. Monetary policy in an inflation-targeting regime is often characterized by a simple inflation-forecast-based (IFB) rule of the form given by equation (2). The feedback horizon, k , is inversely related to the degree of structural persistence in inflation. If inflation is intrinsically persistent, then monetary policy must be forward looking to avoid taking action too late. All else being equal, the more persistent is inflation, the longer it takes for policy to have its maximum impact on inflation. If policy does not react until the full impact of inflation is observed, then the peak impact of the policy response will occur after the effects of the shock have already begun to dissipate, meaning that policy will be behind the curve. This, in turn, will tend to destabilize output. Thus, the feedback horizon should be longer in environments with higher structural persistence in inflation.

As Batini and Haldane (1999) note, the optimal feedback horizon tends to be closely related to the length of time it takes for a change in monetary policy to have its peak impact on inflation. At this horizon, the cumulative change in demand conditions required to stabilize inflation is minimized. If the feedback horizon is shorter than this, then policy must induce greater movements in aggregate demand to return inflation to target.

Price-level targeting

Recent research suggests that price-level targeting may have beneficial properties relative to inflation targeting. In particular, PLT can yield a lower variance in both inflation and the output gap. This result is, however, sensitive to assumptions about the degree of inflation persistence.

PLT outperforms IT in a forward-looking environment because it induces stabilizing movements in expected future demand conditions—a term in the NKPC. As Ambler (2009) explains, stabilizing the price level after a positive markup shock requires a period of below-average inflation. The anticipation of this drop reduces the initial impact of the shock on inflation. This improves the short-run trade-off between inflation and output stabilization.

This result does not necessarily hold in a more general environment in which some firms use simple rules of thumb to set prices. For example, Coletti, Lalonde, and Muir (2008) show that as the proportion of ROT firms rises above 50 per cent, IT is preferred to PLT. Nevertheless, calibrating the NKPC to match the

²⁶ This is also true for a decline in the persistence of markup shocks.

degree of inflation persistence in Canada during the inflation-targeting era implies that only a small proportion of firms follow simple rules of thumb (Benati 2008; Murchison and Rennison 2006). This lends support to the idea that PLT can yield material improvements over IT for economic stability in Canada.

The benefits of PLT also depend crucially on the assumption that economic agents understand the policy regime. In the period immediately following a switch from IT to PLT, economic agents may not fully appreciate the differences between the two regimes. If firms do not understand PLT, they will not take account of its effect on future demand conditions when setting prices. Kryvtsov, Shukayev, and Ueberfeldt (2008) show that, in this situation, PLT can lead to worse outcomes than IT. The reason is simple: failure to correctly understand the policy regime cuts off the expectations channel. Thus, the speed with which economic agents learn to understand the new regime is an important factor in assessing the merits of moving from IT to PLT.

The benefits of PLT depend crucially on the assumption that economic agents understand the policy regime.

Gaspar, Smets, and Vestin (2007) study the transition from IT to PLT in an environment in which economic agents learn about the new regime through econometric estimation. The rate at which agents learn depends on the information they can glean from observed data. The authors show that the speed of learning is faster, and the transition costs smaller, if the degree of structural inflation persistence is lower.

Given these results, it is tempting to conclude that ROT behaviour is not a concern for PLT in Canada. A potential risk to this conclusion is that it treats the importance of ROT behaviour as fixed across policy regimes. Amano, Mendes, and Murchison (2009) show that a major regime change may lead firms to revisit their decision to follow a simple ROT. Firms likely choose to do so in order to economize on the costs of gathering information and of rationally forecasting future economic conditions. Their willingness to follow an ROT will depend on how well that rule performs in terms of profitability relative to the profits associated with forward-looking behaviour.

These authors show that PLT may improve the relative performance of simple ROTs by reducing the variance of inflation and output. This could lead to an increase in the number of ROT price-setters that would undermine the performance of PLT. Thus, it may be inappropriate to treat the proportion of ROT firms as constant across policy regimes.

This result reinforces the point that, when evaluating alternative policy regimes, it is crucial to carefully consider the underlying reasons for observed economic behaviour. As this example demonstrates, taking into account the behavioural responses of economic agents can cause a source of structural persistence to become regime dependent. Though it is difficult to predict the precise nature and magnitude of behavioural responses, it is nonetheless valuable to analyze the risks they pose.

Conclusion

In contrast to the 1970s and 1980s, the past two decades in Canada have been characterized by very low inflation persistence, and the timing of the reduction appears to coincide with the formal adoption of inflation targeting by the Bank of Canada. Theoretical explanations for the observed decline include good monetary policy, structural change, and the good luck argument. Good monetary policy has been linked to a decoupling of long-term inflation expectations from current economic conditions, as well as to lower variance in inflation and output, since monetary policy now actively responds to economic developments in order to maintain price stability. Simulations with ToTEM suggest that changes to the conduct of monetary policy can explain most, but not all, of the observed decline in inflation persistence. These results also suggest that the underlying degree of structural persistence in inflation in the Canadian economy is low. Other things being equal, this means that monetary policy in Canada need not be as forward looking as it would need to be if persistence was high. It also means that the optimal time horizon over which inflation should return to the target, following a disturbance, is shorter than would otherwise be the case.

For a central bank considering the relative merits of price-level versus inflation targeting, recent research suggests that low structural persistence in inflation will tend to favour the former. Moreover, the transition period to a price-level-targeting regime, when the private sector may still be learning about the precise nature of the change, appears to be less costly when structural inflation persistence is low.

As central banks continue their search for better policy frameworks, it is crucial that account be taken of the profound economic changes that a new policy regime can bring about. Just as inflation targeting brought about a significant change in the properties of inflation and output growth in Canada, so too could other monetary policy regimes. To accurately compare and rank various policy alternatives, behavioural

responses must be considered. Recent research at the Bank of Canada has begun to focus on possible changes to the nature of price-setting behaviour in a price-level-targeting regime. Future work will focus on extending this approach to other aspects of private sector behaviour.

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The Evolution of Capital Flows to Emerging-Market Economies

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- *Many emerging-market economies (EMEs) have significantly improved their macroeconomic fundamentals and undergone structural reforms since the 1997 Asian crisis.*
- *These developments have enhanced the composition of capital flows to EMEs, including an improved debt structure, a larger share of capital flows in the form of foreign direct investment, and greater access to international debt markets for corporations in EMEs.*
- *Despite these positive developments, increased financial linkages left many countries vulnerable to external disruptions in 2007–09.*

Flows of private capital to emerging-market economies (EMEs) fell off sharply as the global financial crisis deepened: total net private capital flows, which reached a record high of US\$1.2 trillion in 2007, fell to only US\$649 billion in 2008 and are estimated to have fallen to US\$435 billion in 2009.¹ The downturn affected all developing regions, albeit to various degrees, with emerging Europe being the worst affected. Following a period of net outflows between October 2008 and March 2009, private capital flows to most EMEs resumed in the second and third quarters of 2009. While portfolio equity inflows have rebounded quickly, total private capital inflows are forecast to reach only US\$722 billion in 2010, about half of their 2007 levels. In some countries, however, rapid capital inflows have raised concerns regarding the impact of such flows on financial stability or on the exchange rate, and capital controls on inflows are being implemented or considered. Whether these controls are temporary or long-term in nature, and how effective they will be, remains to be seen.

This article has two objectives. First, it highlights that lessons learned from the Asian crisis have prompted EMEs to improve their macroeconomic fundamentals and to implement structural reforms—developments that have enhanced the composition of capital flows to these countries. In particular, EMEs have improved their fiscal positions. Some have adopted inflation targeting and allowed a more flexible exchange rate, while others have accumulated substantial foreign exchange reserves. Many EMEs have also avoided running large current account deficits. This has led to (i) greater investor confidence, (ii) an improved debt structure (seen in the shift from external to domestic debt markets and from short to longer maturities), (iii) a larger share of capital flows in the form of foreign direct investment (FDI), which tend to be more stable,

¹ Institute of International Finance (IIF) figures for 2009, based on a sample of 30 key emerging-market economies.

and (iv) greater access to international debt markets for corporations in EMEs, both in terms of bank borrowing and new bond issuance.

These positive developments have been reinforced by structural changes in the global financial landscape. For example, financial innovation, such as growth in the market for credit default swaps (CDS) for developing-country debt, has enabled greater risk distribution. Taken together, these developments led to an increase in capital flows that has brought significant economic and financial benefits (from increased trade and financial integration). The improvement in the composition of capital flows has also made some EMEs more resilient to external shocks.

Second, the article argues that the developments that have improved capital flows have also increased the likelihood of contagion when global economic conditions deteriorate. The growing share of countries with open capital accounts has widened the scope for rapid capital outflows in response to deteriorating economic conditions. Thus, even though most EMEs maintain better policies and have stronger institutions than they did at the onset of previous crises, many remain vulnerable to external disruptions. The vulnerability of EMEs to shocks varies considerably, however. Countries with large current account deficits that rely heavily on external financing seem to be particularly vulnerable, while EMEs holding large foreign exchange reserves or running current account surpluses are better positioned to withstand disruptions in capital inflows.

The severity of the recent financial crisis in emerging markets and the risks of further spillovers call for a continued strong and coordinated response from policy-makers at the global level. Currency-swap lines between major central banks and a broader range of support for EMEs by international institutions (such as the IMF's flexible credit line) are examples of policies that appear to have enhanced confidence and reduced the negative spillovers of the crisis to EMEs.² In addition, policy-makers need to implement policies that support capital flows, and ensure that capital controls, if implemented in response to a financial

crisis, are of a temporary nature.³ While capital controls may be beneficial in the short run, such measures are inherently distortionary, and their long-run effects are likely to be detrimental to the broader economy. In fact, capital flows can be beneficial for EMEs and for the international financial system as a whole. Thus, policy-makers in emerging markets need to continue to strengthen their financial systems and policies to meet the ongoing challenges of the global economic environment.

Background

Capital flows since 2000

From 2002 to 2007, net capital flows to EMEs grew nearly fivefold to US\$1.2 trillion, a level higher than that prior to the East Asian and Russian crises (**Chart 1**).⁴ Disaggregation of the data reveals that nearly all types of flows increased during this period. Net FDI flows remained resilient, rising steadily from 2003 through to the end of 2007. Flows of portfolio equity, on the other hand, tended to be more sensitive to shifting conditions in the global business cycle and to global risk tolerance. They were relatively strong in 2005–06, averaging about US\$52 billion per year.

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These flows began to fall in 2007, however, eventually turning into net outflows (US\$8 billion) for the year as a whole, and deteriorated further to an outflow of US\$92 billion in 2008. Net bank flows to EMEs grew steadily from 2003 to 2007, reaching a peak of about US\$366 billion in 2007. Again, these flows plunged in

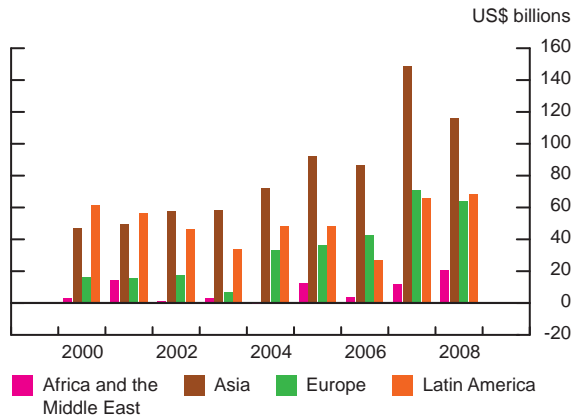
² In the past, IMF facilities have been associated with adverse signals. However, the flexible credit line (FCL) is designed for countries deemed to have very strong fundamentals, policies, and track records of policy implementation. Thus, an FCL does not necessarily send adverse signals to the market.

³ The literature is divided on the benefits and costs of capital controls. Such controls may be beneficial in the short run (e.g., in response to a crisis) or in initial development stages (when countries have an underdeveloped financial system). However, in the long run, capital controls tend to become less effective and have detrimental effects on the economy. For an overview of the literature, see Kawai and Takagi (2008).

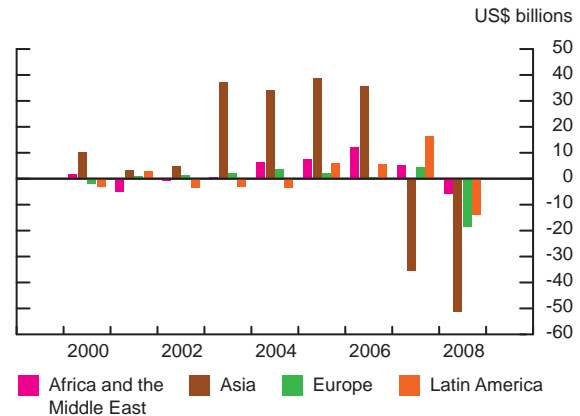
⁴ Private net flows plus official net flows.

Chart 1: Capital flows to emerging markets

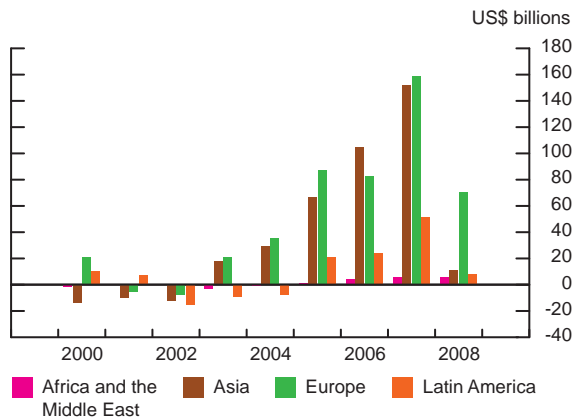
a. Net FDI flows to EMEs



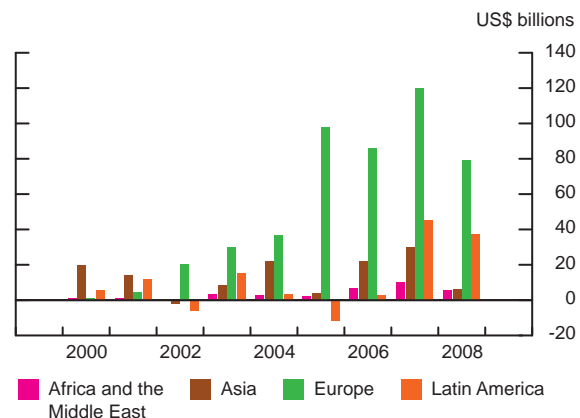
b. Net portfolio flows to EMEs



c. Net bank flows to EMEs



d. Other net debt financing



Note: Emerging Asia includes China, India, the Philippines, Thailand, Indonesia, Korea, and Malaysia. Emerging Europe includes Croatia, Romania, Turkey, Poland, Russia, the Czech Republic, Bulgaria, Hungary, and Slovakia. Africa and the Middle East includes South Africa, Egypt, and Morocco. Latin America includes Ecuador, Chile, Peru, Venezuela, Mexico, Brazil, Colombia, and Argentina.

Sources: Institute of International Finance and authors' calculations

2008 across all regions to a total of US\$95 billion.^{5,6} The effects of these flows remain an ongoing concern for policy-makers in emerging markets.

⁵ Note that *net* capital flows may understate the level of capital flows in EMEs, because these flows denote *net inflows* (i.e., investment flows into EMEs minus withdrawn investments, dividends, etc.) minus *net outflows*, the latter including, for instance, growing outward investment from EMEs (private portfolio investors, sovereign wealth funds, etc.). In fact, in aggregate, capital is now flowing from EMEs to the low-saving developed economies, especially the United States.

⁶ This plunge was partly caused by global deleveraging, re-emerging home bias in investment, and a reduction in loans to EMEs by international banks trying to overcome severe liquidity shortages in their home markets.

The implications of capital flows

Although capital flows often benefit EMEs, very rapid inflows can be difficult to absorb.⁷ In fact, one lesson from the 1997 Asian crisis is that capital flows can significantly influence macroeconomic outcomes: the crisis was preceded by appreciation pressures stemming from strong capital inflows and global liquidity, which, in turn, culminated in higher asset prices. The “sudden stops” (or reversals in capital

⁷ There has been an intense debate in the literature about the long-run growth benefits of capital flows. Some argue that unfettered capital flows are a serious impediment to global financial stability (e.g., Rodrik and Subramanian 2009), while others argue that increased openness to capital flows has been essential for countries aiming to move from lower- to middle-income status (e.g., Mishkin 2008).

inflows) that followed were then associated with sharp currency depreciations, collapsing asset prices, and severe economic downturns.

The situation of EMEs in the lead-up to the recent crisis bears both similarities and differences to the conditions prevailing prior to the 1997 Asian crisis. Apparent similarities include appreciation pressures, abundant global liquidity (up to mid-2007), and rapidly rising asset prices. There are, however, important differences, since many EMEs have learned the lessons from the Asian crisis and have become more resilient to financial disruptions.⁸ First, governments improved fiscal policy and, in many cases, implemented strong monetary policy frameworks. Second, strong economic growth, along with improved standards of corporate governance, attracted a steady inflow of capital, supported by benign conditions in the global economy (until mid-2007). Third, many EMEs, such as China, Russia, India, Korea, and Brazil, have accumulated record levels of foreign exchange reserves, implying that they are less vulnerable to “sudden stops” than in the past. Fourth, FDI flows are now larger than portfolio investment flows (Chart 1-a and 1-b), reducing the likelihood of a rapid reversal in capital flows. And fifth, in recent years, capital inflows (the result of the strong policy frameworks mentioned above), have been associated with current account surpluses. While there are some notable exceptions, these developments suggest that most EMEs are far more resilient than before.

How Have Capital Flows to Emerging Markets Changed?

Improvements in the underlying macroeconomic fundamentals of many EMEs over the past few years have contributed to significant changes in the structure and composition of capital flows. These include structural changes in emerging-market debt, the development of equity markets, and growth in external corporate debt.

Structural changes in emerging-market debt

That debt markets in emerging economies are evolving can be clearly seen in the diversification beyond U.S.-dollar-denominated, high-yield, sovereign debt instruments. The three main structural changes are: growth of domestic debt markets, lengthening of debt

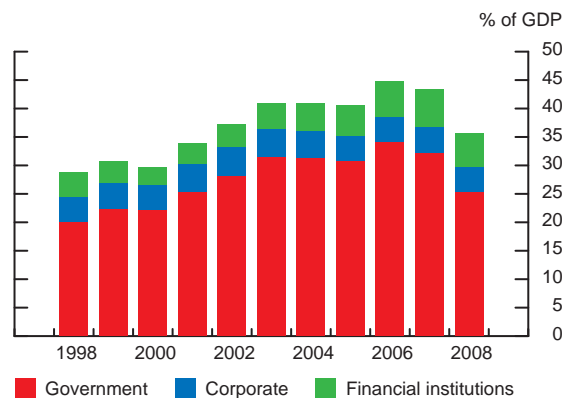
⁸ Perrault (2002) describes improvements in the composition of capital flows in the aftermath of the Asian crisis.

maturity, and financial innovation in the form of credit derivatives.

Growth of domestic debt markets

Until the late 1990s, markets for domestic fixed-income (public) securities were relatively underdeveloped in many countries in Latin America, Asia, emerging Europe, and Africa, with total outstanding domestic debt securities in EMEs at 20 per cent of GDP in the mid-1990s. Many EMEs have been shifting towards the issuance of local-currency debt, reflecting better fundamentals, greater foreign investor appetite, and a growing domestic institutional investor base. And until

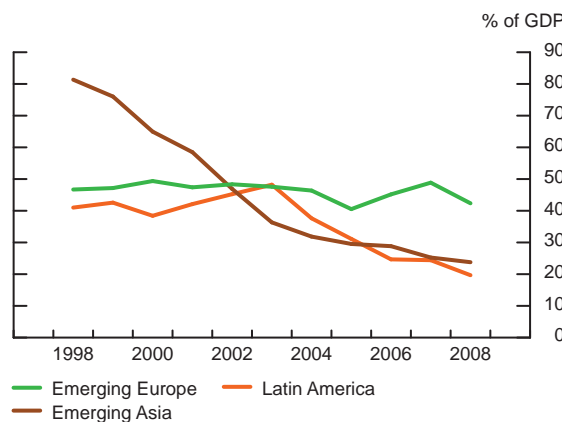
Chart 2: Outstanding domestic debt in emerging markets



Note: Figures are averages of outstanding domestic debt by sector. Countries include: Argentina, Brazil, Chile, China, Colombia, the Czech Republic, Hungary, India, Indonesia, Malaysia, Mexico, Pakistan, Peru, the Philippines, Poland, Russia, Slovakia, South Africa, South Korea, Thailand, Turkey and Venezuela.

Sources: *BIS Quarterly Review* December 2009; Institute of International Finance; International Monetary Fund, *International Financial Statistics*

Chart 3: Total external debt of emerging markets



Note: Figures are the median total external debt (percentage of GDP) for selected emerging markets in each region.

Source: Institute of International Finance

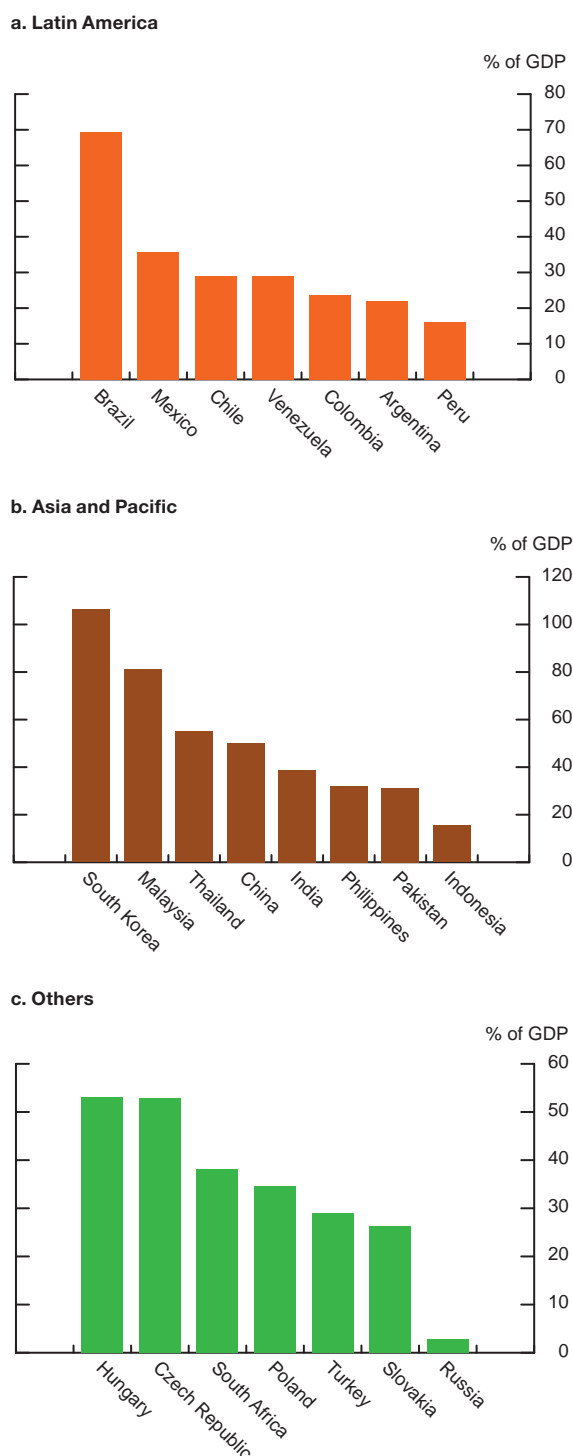
2007, benign global financial conditions allowed these countries to lock in longer-term funding and improve debt structures. Consequently, from 1998 to 2008, total outstanding domestic debt securities grew from 29 per cent of GDP to almost 36 per cent, driven mainly by the public sector (**Chart 2**). During this period, total external debt (i.e., public and private) declined (**Chart 3**).

In the past, there were doubts about the ability of emerging markets to borrow in international financial markets in their own currency—a phenomenon referred to as “original sin.”⁹ However, over the past decade or so, many EMEs have overcome “original sin,” through greater issuance of bonds denominated in their own currencies in international financial markets, as well as through the development of their domestic bond markets. With regard to the former, Brazil, Colombia, Mexico, Peru, and Uruguay have issued international bonds denominated in their currencies over the past five years, and both foreign and local investors have been active in these local-currency markets, owing to the fact that many EMEs have been following better macroeconomic policies, thus giving investors greater confidence in their domestic-currency bonds.

Local-currency bond markets in developing countries have become a major source of financing and were the fastest-growing segment of EME debt until 2007.

Local-currency bond markets in developing countries have become a major source of financing and were the fastest-growing segment of EME debt until 2007 (**Chart 4**). These markets are concentrated in eight countries: Brazil, China, India, the Republic of Korea, Malaysia, Mexico, Turkey, and South Africa. Until recently, they were largely closed to foreign investors. However, gradual and steady liberalization of capital accounts in several countries has led to increased foreign participation.¹⁰ Foreign investment in local-currency bond markets has been further facilitated by

Chart 4: Outstanding domestic-currency debt in emerging markets, 2008



Sources: Bank for International Settlements; International Monetary Fund, *International Financial Statistics*

⁹ The term “original sin” was coined by Eichengreen and Hausman (1999) and refers to a country’s inability to borrow abroad for long terms in its own currency. If the country accumulates net debt, it will consequently have an aggregate currency mismatch on its balance sheet.

¹⁰ Benign global financial conditions and the search for yield also enabled EMEs to issue more debt in local currency.

the introduction of local-currency bond indexes, such as JP Morgan's Government Bond Index-Emerging Markets (GBI-EM), launched in 2005.¹¹

Lengthening maturity structures

Until the 1990s, short-term debt constituted a large share of EMEs' total outstanding debt, partly because of the high risk premium charged by international capital markets on long-term debt. Improved fundamentals, including lower inflation, more responsible fiscal policies, and current account surpluses, have reduced the risk of a crisis and, combined with global investors' search for yield, have enabled EMEs to lengthen the maturity structure of their debt. Consequently, the share of short-term external debt in total international debt securities has declined over the past decade. This is true for both sovereign and private debt issues. Latin America has seen an impressive decrease in short-term debt from more than 20 per cent in 2000 to less than 9 per cent by the end of 2007. However, flows of short-term debt (primarily bank loans and trade credit) increased in 2007 by US\$35 billion and were concentrated in Latin America and the Caribbean.¹² Europe and Central Asia still accounted for almost half of the total flows (World Bank 2008).

In addition, emerging markets have moved away from floating-rate debt towards fixed-rate debt: In 1994, over half of the total outstanding issuance of emerging-market debt securities was floating rate in nature. In 2007, only 2 per cent of the total outstanding issuance of emerging-market debt was floating rate in nature (Business Wire 2008). At the same time, the share of inflation-indexed bonds in EME issuance is declining (Medeiros 2006).

The implication of this development for the resilience of capital flows to EMEs is clear. Studies on debt crises conclude that a shorter and more concentrated debt structure increases the likelihood of a debt crisis.¹³ In addition, short-term or floating-rate debt may increase a country's exposure to sharp increases in interest rates, which may have additional consequences, since governments may need to increase taxes in order to service the debt (see Barro 1997). Longer maturities, on the other hand, imply smaller quantities of debt to be rolled over in every period.

Thus, long-term debt is more sustainable (less vulnerable to rollover risk), making the transition to a longer debt structure beneficial for EMEs.

Financial innovation: credit derivatives

Credit derivatives have become increasingly important instruments for investors in emerging markets in recent years. In particular, credit default swaps (CDSs), securities that insure against the event of default on an underlying bond, are gaining importance and are estimated to account for a large share of the face value of the international debt securities of emerging markets. CDSs are being used in securities markets in Bulgaria, the Republic of Korea, Mexico, Peru, the Philippines, and the Russian Federation.

This strong growth in CDS contracts reflects increased international investor demand for exposure to emerging markets. In the face of declining net issuance of emerging-market external debt, investors have met their targets for emerging-market exposure by selling protection on sovereign issues. CDS contracts have important implications for the pricing and supply of debt capital to developing countries, because they offer investors another way of assuming exposure to emerging-market risk and enhance the markets' ability to gauge credit risk. The massive growth in the CDS market could, indeed, enable better risk distribution and provide for more complete markets, but tracking who is assuming what risks may become very difficult. There is also the risk that some investors will take large positions without fully understanding them, and thus a shock may cause market turbulence.

Credit derivatives have become increasingly important instruments for investors in emerging markets.

Equity Markets

Strong economic growth in EMEs over the past few years has been accompanied by the rapid appreciation of local equity markets. From 2004 to May 2008, the MSCI emerging-markets index rose nearly 170 per cent (**Chart 5**), despite the financial market turbu-

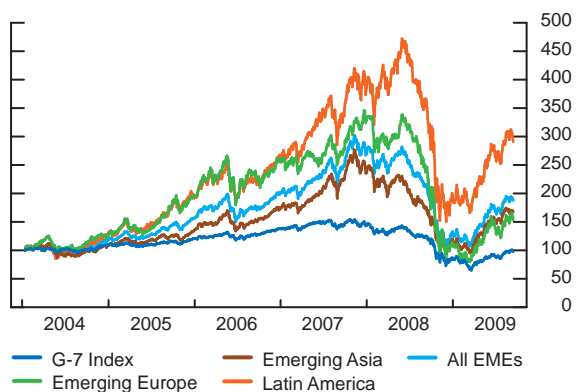
¹¹ Other such indexes include JPMorgan Chase's Emerging Local Markets Index (ELMI) and the Lehman Global Aggregate Index.

¹² Some of the flows to this region reflect activities in offshore financial centres for which only limited information is available.

¹³ For example, Alesina, Prati, and Tabellini (1990) and Cole and Kehoe (1996).

Chart 5: MSCI emerging-market indexes by region

1 January 2004=100



Note: Emerging Europe includes the Czech Republic, Hungary, Poland, Russia, and Turkey. Latin America includes Argentina, Brazil, Chile, Colombia, Mexico, and Peru. Emerging Asia includes China, India, Indonesia, Korea, Malaysia, Pakistan, the Philippines, Taiwan, and Thailand.

lence.¹⁴ Foreign investors have increasingly taken part in this stock market boom, resulting in a record level of inflows of portfolio equity in 2006 of \$US53 billion, followed by a sharp decline in equity portfolio flows during the financial crisis (Chart 1-b).¹⁵ The greater supply of foreign portfolio equity has had several benefits for corporations in EMEs. It has lowered the cost of capital and allowed financially constrained firms to expand. Moreover, growing foreign participation in EME stock markets has greatly increased the liquidity of local stock markets, which has contributed to the strengthening of EME financial systems. Research suggests that the increased liquidity of equity markets is highly correlated with future economic growth.¹⁶

Equity markets in EMEs have undergone a series of reforms since the early 1990s, which have increased the interest of foreign investors. Reforms have boosted competitive conditions in these markets and have improved investor confidence as EMEs have put in

place better regulatory frameworks and reduced transactions costs and information asymmetry. In addition, corporations in EMEs are increasingly accessing international equity markets, driven by growing demand from investors and by the increasing participation of these companies in international business transactions. One factor allowing them to access foreign capital in equity markets is improved corporate governance. Well-governed companies are able to raise such financing at significantly lower cost than poorly governed companies because of the additional risk premium that investors demand from the latter.¹⁷ In addition, countries that put in place laws and supporting institutions to protect the rights of minority shareholders have increasingly attracted foreign investors.¹⁸

There is considerable heterogeneity in the composition of portfolio flows across EMEs, and these patterns can be explained by their respective policies regarding the capital account. For example, the liberal approach of countries in emerging Asia to portfolio flows relative to that of the 1990s, combined with promising growth prospects, made them the primary destination of portfolio capital flows, which reached a peak of US\$35 billion in 2006, or 66 per cent of total portfolio flows to EMEs.¹⁹ China, in particular, attracted a large portion of these flows. Growing demand from institutional investors, such as hedge funds, supported equity issues. In India, on the other hand, early relaxation of restrictions on equity inflows has shifted the composition towards portfolio investments, which accounted for one-third of capital flows in 2007. In contrast, portfolio equity flows to emerging Europe represent only a small fraction of capital flows, of which Russia and Turkey attracted the majority. Relatively weak portfolio flows to eastern Europe may be attributed to poor corporate governance: the risk that profits may be diverted either by insiders or through political intervention.

External corporate debt

In the years leading up to the global financial crisis, corporations and financial institutions in EMEs borrowed in international debt markets on an unprecedented scale. This was reflected in the surge

¹⁴ The MSCI EM index is a float-adjusted market capitalization index that measures the performance of equity markets in EMEs. It consists of indexes in 26 emerging economies: Argentina, Brazil, Chile, China, Colombia, the Czech Republic, Egypt, Hungary, India, Indonesia, Israel, Jordan, Korea, Malaysia, Mexico, Morocco, Pakistan, Peru, the Philippines, Poland, Russia, South Africa, Taiwan, Thailand, Turkey, and Venezuela.

¹⁵ Note that data for net flows of portfolio equity underestimate these flows into EMEs. The former denote net inflows (which denote investment flows into EMEs minus withdrawn investments, dividends, etc.) minus net outflows (i.e., the purchase of a foreign stock by an EME private portfolio investor or sovereign wealth fund is a negative inflow). Sizable outward investments by portfolio equity investors in Korea and, in 2007–08, in China weakened net inflows.

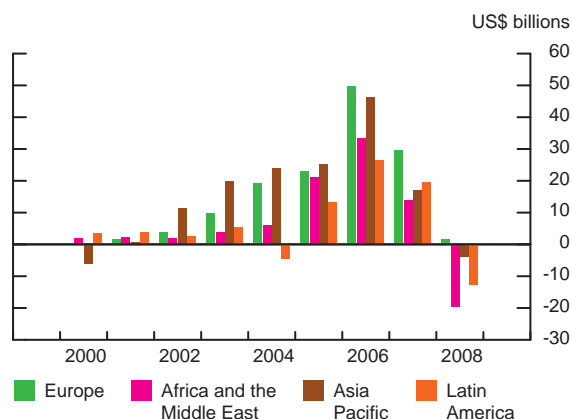
¹⁶ For example, see Levine and Zervos (1998) and Rajan and Zingales (1998).

¹⁷ See OECD (2004) for a review of the evidence in OECD countries. See also Fremont and Capaul (2002).

¹⁸ Henry and Lorentzen (2003) find that countries that have instituted such provisions tend to have larger, more efficient, and more stable stock markets than those without them.

¹⁹ Note that capital flows to emerging Asia fell sharply in 2007–08 (see Chart 1).

Chart 6: EME corporate and financial issuers of international debt



Source: Bank for International Settlements

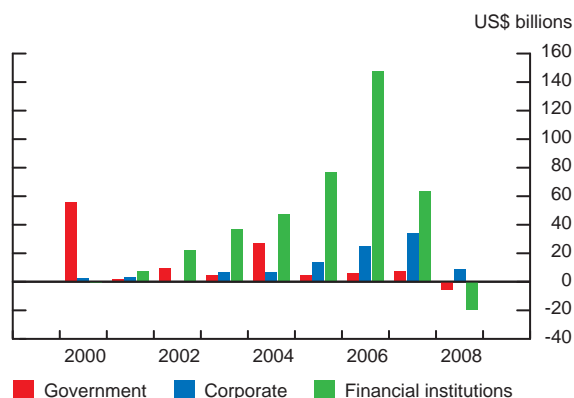
in the net issuance of international bonds (Chart 6),²⁰ and in increased borrowing from external banks (Chart 1-c). The opening of the global corporate bond market to a growing number of private (and public)

The opening of the global corporate bond market to a growing number of private (and public) companies from EMEs is an important structural change for financing in emerging markets.

companies from EMEs is an important structural change for financing in emerging markets. Access to international capital markets allows companies in EMEs to diversify their source of funds, borrow at longer maturities, gain international visibility, and reduce the cost of capital. The use of more sophisticated financing instruments also encourages better risk management. Accessing foreign capital markets also allows firms to reduce their dependence on local capital markets while exposing them to higher standards of accounting, reporting, disclosure, and corporate governance (Coffee 1999, 2002; Stulz 1999;

²⁰ Note that net issuance of bonds is calculated as inflows minus outflows, such as repayments. Data on gross issuance in the international market show that bond issuance rose by 23 per cent (from US\$124 billion to US\$154 billion) in 2007 (for a 30-country sample).

Chart 7: Net issuance of international debt by EMEs



Source: Bank for International Settlements

Reese and Weisbach 2002). The recent participation of corporations from EMEs in international capital markets may also help boost the access of smaller corporate players. First-time borrowers can face high costs, because lenders must expend considerable resources in obtaining information. Once these initial expenses are absorbed, the marginal cost of making subsequent loans is lower, reducing financing costs for all borrowers. A sound macroeconomic environment, ongoing financial liberalization, and improved corporate governance have contributed to this enhanced access of EME corporations to external financing.

Bond issuance by corporations in EMEs (including financial institutions) grew from 34 per cent of total issuance in 1995 to 92 per cent in 2007, greatly exceeding the issuance of sovereign bonds (Chart 7). Broadly speaking, the decline in sovereign bond issuance can be attributed to sound macroeconomic policies: fiscal authorities have tightened spending, resulting in lower ratios of public sector debt to GDP and substantial principal repayments on sovereign bonds. Moreover, most EMEs have repaid large amounts of external sovereign debt and have shifted public sector borrowing to the domestic bond market. The increased engagement of EME corporations in international capital markets has, in turn, been driven by two structural forces: (i) growing demand from investors seeking higher yields and investment diversification and (ii) privatizations in the corporate sector and companies' increasing participation in international business transactions. Improved domestic macroeconomic policies and liberalization of capital controls by several EME governments have also enhanced the ability of corporations to access international financing.

The growing importance to EME firms of cross-border borrowing in capital markets since the early 2000s has raised a new set of policy challenges for developing countries and for the global economy, including concerns about corporate foreign debt. After the Asian crisis, most EMEs developed more open capital accounts, improved their local capital markets, and significantly reduced their external public debt. Such reforms tended to shift the locus of currency and credit risk associated with external borrowing from the sovereign to the corporate sector, with important implications for the conduct of policy. Indeed, overreliance on international sources of capital may have some drawbacks. For example, as corporations in EMEs have grown and expanded their international operations, they have increased their exposure to interest rate and currency risks. This greater foreign exposure has heightened the vulnerability of these firms to a drying up of foreign financing, such as occurred in the recent financial crisis.

The Impact of the 2007–09 Crisis: Lessons Learned

The recent changes in the nature of capital markets and flows made some EMEs more resilient to the financial crisis. At the same time, rapidly growing trade and the financial integration of EMEs into the global economy over the past decade left some EMEs more vulnerable to contagion in the face of deteriorating global economic conditions. Countries that had adopted sound macroeconomic and financial policies appear to have fared better: they were more resilient and began to recover sooner.

Overall, EMEs withstood the recent financial turmoil better than in previous crises.

Overall, EMEs withstood the recent financial turmoil better than in previous crises. In fact, capital flows remained robust until the collapse of Lehman Brothers in September 2008. This is likely the result of stronger policy frameworks. Indeed, the growing popularity of inflation targeting, increased flexibility of exchange rates, greater ability to issue debt in domestic currency, and generally improved fiscal positions have led to justified perceptions that EMEs have significantly improved their economic fundamentals over the past decade. The high level of foreign exchange reserves held by many EMEs has also helped to

maintain confidence, albeit at the cost of inflexibility in the real exchange rate (for some) and the buildup of global imbalances over the medium term. Research also suggests that attempts to reduce the vulnerability of individual countries in more normal times, such as smaller current account and fiscal deficits, can lower the level of financial stress in EMEs and may limit the implications for the real economy (IMF 2009). Once financial stress recedes in the advanced economies, lower current account and fiscal deficits can help to re-establish financial stability and inflows of foreign capital.

With respect to the composition of capital flows, countries that had attracted larger shares of FDI flows generally fared better in the crisis. FDI flows held up fairly well, and despite some weakness in early 2009, no “fire sale” of FDI has occurred, such as took place in emerging Asia in the late 1990s.²¹ Recent research also shows that a large pre-crisis exposure to inflows of FDI capital was associated with a less-severe credit crunch during the recent crisis (Tong and Wei 2009).²² As in previous crises, the reversal in flows during the 2007–09 crisis came in two main categories: net flows of portfolio equity and net bank lending. Countries that depended mainly on these flows were less well positioned to deal with the drying up of liquidity in the financial crisis. Portfolio equity flows were affected as early as 2007, as investors scrambled out of illiquid EME equity markets. Net bank lending to EMEs fell sharply in 2008, partly because of global deleveraging, a re-emerging home bias, and the reduction of loans to EMEs by international banks in order to overcome severe liquidity shortages in their home markets. Bond markets, on the other hand, while also having been severely hit, appear to be recovering quickly. Moreover, countries with more developed local bond markets have been somewhat more resilient, but not immune, to capital outflows.

Regional differences

EME regions can be grouped by their performance in the financial crisis, based on their progress in improving fundamentals and their reliance on the different components of capital flows. For instance, in Latin America, almost six years of improving current account positions, marked gains in terms of trade,

²¹ FDI flows almost inevitably weaken during downturns in the business cycle, since a portion is accounted for by reinvested earnings, which weaken during periods of recession, when the overall appetite to invest falls.

²² Note that the total volume of pre-crisis capital inflows does not appear to be systematically related to the severity of the credit crunch.

declines in public external debt relative to output, growing international reserves, and financial sector reforms have strengthened the ability of many countries to weather external shocks. In addition, many countries with flexible exchange rates absorbed part of the shock through significant exchange rate depreciation. The banking crisis also had the least severe impact in Latin America, because of a reduction in banking flows over the past 10 years. In fact, the rebound in capital inflows to some countries in Latin America has raised concerns: Brazil, for instance, has imposed controls on inflows.

Emerging Asia also appears to be better positioned than in previous crises, although the region has experienced a collapse in global banking and equity flows.²³ Liabilities to banks in advanced economies declined somewhat in emerging Asia following the 1997–98 crisis, making the region less vulnerable to external banking crises. However, portfolio liabilities have increased markedly in emerging Asia, which led to a rapid withdrawal of portfolio equity in 2007 and 2008. Nevertheless, equity flows rebounded quickly in mid-2009, with equity markets rising strongly. This too has raised concerns that asset prices may deviate from fundamentals if inflows expand too rapidly. High levels of official reserves have also helped cushion the shock, and government budget surpluses have allowed policy-makers to implement important fiscal stimulus packages. Declining inflation has allowed monetary authorities in many countries to cut key policy interest rates. Moreover, sound banking systems in most countries have allowed the effective implementation of measures to help sustain domestic liquidity and the availability of credit. Liquidity in local currency has remained broadly adequate, and interbank rates have declined or remained stable.

On the other hand, the buoyant economic growth in central and eastern Europe over the past decade was fuelled by a strong expansion of credit that relied largely on external financing and led to rising levels of external debt, as was the case in the 1997 Asian crisis. Current account deficits widened on the back of booming private consumption and have been running in the double digits in the Baltic States, Romania, Bulgaria, Bosnia, and Serbia.²⁴ Bank liabilities to advanced economies have grown rapidly in emerging Europe and are now over 50 per cent of

GDP, which is about three times the level in other emerging-market regions, making the region more vulnerable to external bank crises (World Bank 2009). Large currency mismatches in banks' portfolios, short maturities, and the rapid expansion of bank credit to the private sector have made repaying or rolling over loans especially problematic. In addition, countries with fixed exchange rate regimes only slowly adjust to large external imbalances, because the entire burden of adjustment is borne by domestic mechanisms, particularly fiscal policy. In many important ways, therefore, eastern European countries headed into the crisis with weaker macroeconomic fundamentals than countries in emerging Asia or Latin America. The impact of the crisis has thus been more dramatic and will likely be longer lasting than in other regions.

Overall assessment

Taken together, the sound policies adopted before the crisis have allowed many EMEs to better weather and respond to the financial turbulence. Nevertheless, improved fundamentals have not prevented the transmission of financial stress from advanced economies to EMEs. The growing levels of trade and the financial integration of EMEs into the global economy over the 2002–07 period left many countries vulnerable to fallout from the crisis, despite the improvements in the composition and nature of capital flows. Trade linkages have become increasingly important over the past 20 years, with exports to advanced economies up from less than 10 per cent of emerging economies' GDP to nearly 20 per cent (IMF 2009). Crisis transmission via both trade and financial linkages has been compounded by second-round effects through spillovers from affected emerging economies back to advanced economies and through spillovers within the group of emerging economies. All in all, net private debt and equity flows are projected to decline from a record high of 7 per cent of GDP in 2007 to just over 2 per cent in 2009, exceeding the peak-to-trough drop during the Latin American debt crisis in the early 1980s (3.3 percentage points) and in the combined East Asian and Russian crises of the late 1990s (2.4 percentage points) (World Bank 2009).

Conclusion and Policy Discussion

Despite the turnaround in capital flows in late 2009, these flows have not yet returned to pre-crisis levels. Only a few emerging-market sovereigns were able to issue international bonds in 2009. Bank lending to EMEs fell considerably through the first quarter of 2009 and remained weak throughout the year. There

²³ Markets in East Asia and the Pacific are more liquid than those in other developing regions and have been a dominant destination for equity investors.

²⁴ This happened even though all these countries, with the exception of Romania, ran tight enough fiscal positions that they would have met the Maastricht criteria in 2008.

is also increasing evidence of a drop in FDI inflows to EMEs. According to World Bank estimates, net private debt and equity flows to EMEs are projected to decline from a high of 7 per cent of GDP in 2007 to a mere 2.6 per cent in 2010.

The past decade has been characterized by ongoing financial liberalization in many EMEs which, in turn, has resulted in the growing integration of these countries into the global economy. In theory, financial and capital account liberalization should lead to a better allocation of savings, more efficient investment, and thus higher long-run economic growth. The increasing integration of EMEs in the global economy has, indeed, brought substantial economic and financial benefits, but it has also magnified the potential impact of any deterioration in global economic conditions. Thus, even though most EMEs now follow better macroeconomic policies than they did at the onset of previous crises, more are now vulnerable to external disruptions. In particular, the recent global crisis has highlighted that financial and capital account liberalization can result in poor economic outcomes unless accompanied by appropriate regulation and supervision. Moreover, sequencing is an important element to consider in the context of capital account liberalization: simply, certain institutional arrangements need to be in place first, including supervisory and regulatory capacity, appropriate legal standards and other institutional features that can help maintain financial stability in the presence of capital inflows (Kawai and Takagi 2008; McKinnon 1993). Indeed, the crisis has sparked widespread interest in tighter regulation of financial

institutions, financial markets, and financial transactions (Barroso 2009). Additional regulation should be implemented in a nuanced and targeted manner, however, since excessive regulation may not always be the appropriate response (Schembri, Santor, and Epstein 2009).

Even though most EMEs now follow better macroeconomic policies than they did at the onset of previous crises, more are now vulnerable to external disruptions.

The recent crisis has also prompted a number of EMEs to impose controls on capital outflows. Some countries may also react by increasing their holdings of official reserves and maintaining undervalued exchange rates. There is also the risk that some countries may use capital controls beyond emergency needs which, in turn, might restrict their ability to attract capital in the future. Thus, while imposing capital controls may have some benefits in the short run, the long-run effects are likely to be detrimental, since such policies could potentially exacerbate macroeconomic imbalances. Indeed, capital flows are an integral part of a stable and efficient market-based international financial system, and policy-makers need to enact policies that would support such flows.

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Making Bank Notes Accessible for Canadians Living with Blindness or Low Vision

Carolyn Samuel, Currency Department*

- *The Bank of Canada believes that providing Canadians with barrier-free access to currency is important and is necessary for currency to be most effective as a means of payment. The Bank recognizes the special needs of those who are blind and partially sighted and is committed to working proactively to make bank notes accessible to this growing subset of the population.*
- *The development of Canadian bank notes is based on a continuous process that relies on scientific and empirical research, together with direct feedback from bank note user groups and experts. The Bank consults Canadians living with blindness and low vision, as well as their representative organizations and vision experts, to identify the needs of this community and to explore potential solutions.*
- *Through research, collaborative partnerships, and a focus on continuous improvement, the Bank has transformed a limited set of features into a program offering options for individuals with a range of vision limitations and improving their ability to conduct financial transactions using bank notes.*

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Since its establishment in 1935, the Bank of Canada has been committed to supplying Canadians with bank notes that they can use with confidence to carry out cash transactions.

Designing and developing the bank notes that Canadians use every day is complex and challenging. The final notes are the product of continuous improvements involving research, consultation, development, testing, and, ultimately, important public policy decisions and trade-offs.

In deciding which features to include in bank notes, the Bank strives to meet the needs of a wide variety of user groups while remaining focused on the performance of bank notes in terms of security, usability, and cost to society. Although the Canadian general public is the target client, the perspectives of specific subgroups, as well as those of others involved in the use and handling of cash, are also considered. Some of these users include Canadians living with blindness or low vision, financial institutions, retailers, cash handlers, bank note equipment manufacturers, and law enforcement. The Bank must understand the needs of these various groups and must then try to develop notes that meet those needs in the most efficient and effective manner.

This article discusses the Bank of Canada's efforts over the past 30 years to meet the accessibility needs of a specific subset of the population—Canadians living with blindness or low vision. It also reports the findings of expert and user assessments of the suite of accessibility features on the current series of bank notes. The Bank's experience with this group underlines the importance of its relationships with all types of bank note users and the value of understanding their needs and of evaluating how those needs are being met.

Background and Context: Barrier-Free Access to Currency

The Bank of Canada believes that for currency to be most effective as a means of payment, all Canadians should have barrier-free access. The ability to conduct financial transactions using bank notes is crucial to independent living. Yet this can pose significant challenges for individuals who are blind or partially sighted (**see Box**). The Bank recognizes the special needs of this group and is committed to working proactively to make bank notes accessible to this growing subset of the population.¹ This is also an area of increasing concern and focus for bank note issuers around the world (de Heij 2009 and ARINC Engineering Services 2009).

Improving Access for Canadians Living with Blindness and Low Vision

Over the past 30 years, the Bank's approach to improving bank note accessibility for those living with limited or no functional vision has evolved, as have the solutions available. What started as a limited set of features has been transformed into a program that offers options for a range of vision limitations. In working to provide barrier-free access to bank notes, the Bank of Canada has consulted Canadians living with blindness and low vision, as well as their representative organizations and experts on vision and tactility perception, to identify the needs of this community and to explore potential solutions.

What started as a limited set of features has been transformed into a program that offers options for a range of vision limitations.

The early years

In the late 1970s, the Bank began to review and assess possible approaches to making bank note denominations distinguishable for Canadians who were blind or had low vision. Contacts were established with the principal agencies concerned with people living with blindness and vision loss, promising research and development approaches were pursued, and develop-

ments in other countries were studied (Bennett 1982). This early work confirmed a primary objective: personal independence for persons living with blindness and low vision in the day-to-day handling of bank notes.

Birds of Canada series **(first notes issued in 1986)**

In 1978, during the early development of the *Birds of Canada* note series, the Bank's research team identified several possible approaches to assist Canadians with limited or no functional vision in denominating bank notes. Options included (i) notes of different sizes, (ii) clipped note corners, (iii) denomination numbers printed in Braille,² (iv) a hand-held electronic bank note reader, and (v) design enhancements, such as enlarged numerals and stronger colour contrast.

After considerable research and evaluation, the first three options were ruled out. Although different-sized notes are often the first-mentioned choice of individuals living with blindness and low vision, and are found in many major industrialized countries, this change would have substantially increased the cost of handling bank notes for most businesses and individuals. Automated banking machines, cash registers, note-counting/processing equipment, and even wallets would need to be modified or replaced to handle substantially smaller and larger notes than those currently in circulation. Clipping the corners of notes in a pattern so that denominations could be distinguished by touch was also considered. However, clipped corners would cause problems during machine handling and would lead to interpretation difficulties as notes became worn in circulation. Printing a code in Braille on bank notes was also problematic. At the time, it was not possible to produce raised dots that were the height of Braille code with the note-printing processes available. Indeed, research indicated that not all people with vision loss could read Braille. There were also concerns that such dots would wear in circulation.

Even as the list of feasible options shrank, the Bank remained committed to improving accessibility. With promising new technologies on the horizon, the Bank initiated work with a number of research organizations including the National Research Council, Carleton University, bank note printers, and design consultants abroad to research and develop a hand-held electronic bank note reader. This work was facilitated by consultations with agencies that support blind and partially sighted Canadians, including CNIB and CCB

¹ The Bank of Canada (like all federally regulated organizations) is subject to the Canadian Human Rights Act (1977 and 1985) and the principle that all individuals should have equal access to the services customarily available to the general public.

² Braille is a tactile system of raised dots representing letters and numbers.

Defining Vision Loss and Impairment

Vision loss can be described in terms of a range of vision clarity or loss of visual acuity. Visual acuity is expressed relative to normal vision, which in the metric system is set at 6/6 metres (20/20 ft.). This number can be thought of as a fraction of the viewing distance of an object relative to that of someone with normal vision. For example, to see an object, someone with 6/18 (1/3) vision would have to stand at one-third the distance (i.e., 6 metres) of a person with normal vision (18 metres). Those with low vision have visual acuity of less than 6/18 but better than 3/60. People with low vision have difficulty performing common age-related visual tasks in spite of conventional interventions, such as eyeglasses, contact lenses, or eye surgery. Individuals with severe vision loss have visual acuity between 6/60 and 3/60. Even when wearing glasses or contact lenses, individuals with severe vision loss are unable to read ordinary newspaper print or recognize faces across a room. “Functionally blind” individuals have visual acuity of less

than 3/60, and their vision cannot be improved by any means (Jutai et al. 2005).

In response to a 2006 Statistics Canada survey, approximately 816,250 (3.2 per cent) of Canadians aged 15 and older reported having some kind of vision limitation, varying from mild (78.5 per cent) to severe (21.5 per cent). The highest rates of vision limitation were found in those 75 years of age and older (13.4 per cent), a group also more likely to have severe vision loss. More women reported a vision impairment than men (58.9 per cent versus 41.1 per cent) but with no differences in reported severity. Approximately 688,975 (5.5 per cent) of Canadians aged 45 and older reported having some kind of vision limitation.

A study completed in January 2007 for the National Coalition for Vision Health projects that over the next 25 years, the number of Canadians aged 40 years and older living with blindness and vision loss is expected to double as the Canadian population ages.

(Canadian Council of the Blind). The final product was developed and produced by Brytech Inc., an Ottawa-based technology firm, with development funded by the Bank.

The *Birds of Canada* note series was introduced in 1986 and featured two enhancements to assist Canadians living with blindness or vision loss: significantly larger denomination numerals printed with greater colour contrast to help people with low vision,³ and a hand-held electronic bank note reader with bilingual voice output, issued in 1989, that read codes present on all but the \$1000 note.

Canadian Journey series **(first notes issued in 2001)**

Work commenced on the *Canadian Journey* series of bank notes in 1997. As a first step, the Bank reviewed the accessibility features in the *Birds of Canada* notes to identify where improvements could be made.

International best practices were investigated, and consultations were held with experts in the fields of vision and tactility perception and with about 300 Canadians living with blindness or vision loss (with the help of CNIB and the CCB). From this research, the Bank concluded that to be most effective, accessibility features should help the individual to determine the denomination of a bank note quickly, independently, privately, and with the note in any orientation and, to the extent possible, to authenticate the note as genuine. It was subsequently decided that adopting a combination of accessibility features targeting a range of vision loss could greatly improve the situation.⁴ Specific areas for upgrading were identified: better features and tools to denominate; the size, font, and colour contrast of the numerals could be improved; and the bank note reader was considered unreliable, too bulky and heavy, and with only voice output, offered limited privacy.

³ Numerals were enlarged from 8 to 14 mm in height and from 4 to 10 mm in width and were printed on a pale background to provide better contrast.

⁴ For example, tactile features could help blind individuals to denominate, while large numerals and greater colour contrast would help those with vision loss.

To facilitate denominating, two previously considered options were reassessed: different-sized notes and development of a raised-texture tactile feature. Options to further enhance the numerals and to improve the functionality of the bank note reader were also explored. After extensive industry consultations, different-sized notes were again judged to be very costly in terms of their impact on the broader public. Furthermore, the Bank viewed a move to different-sized notes as inconsistent with the trend to more automated dispensing and acceptance of notes in the Canadian market (i.e., ATMs and other note-handling equipment).

Although the development of a raised tactile feature posed a number of technical hurdles, it was appealing because of the potential to help individuals who were blind to denominate bank notes without using a separate tool. Technical research was undertaken in partnership with key stakeholders and experts to develop, manufacture, test, and evaluate such a feature. Canadian Bank Note Company Limited (CBN), one of the Bank's two Canadian-based private sector security printers, developed the approach and produced samples for testing. The Bank worked with a tactility-perception expert from Queen's University to explore symbol design, aiming to maximize tactility within the constraints of available space, production methods, and limits on note thickness for machine handling (Lederman and Hamilton 2002). Forty-eight possible designs were developed, from which six were selected as having the most potential and were subsequently evaluated by a representative group of Canadians living with functional blindness.⁵ The tactile feature chosen is a series of raised-dot patches formed by groupings of six dots separated by a smooth surface that vary by denomination, as shown in **Figure 1**.⁶

To optimize the design of numerals (especially helpful for those with partial vision) the Bank consulted vision experts at the University of Waterloo. Scientific testing was undertaken to determine the optimal numeral size, font, and degree of contrast between the numeral and the background. As a result, notes in the *Canadian*

- 5 The symbols chosen needed to enable quick and reliable denomination, be easily produced, be durable in circulation, and not generate significant costs for the bank note-handling industry.
- 6 Rather than being identified as a Braille symbol, the tactile feature is intended to be felt quickly as a patch that feels rough compared with the smoother background of the note. The scientific reasoning behind using the perception of texture is that the sense of touch is better at detecting and discriminating textures than at identifying raised spatial patterns. Thus it should take less time to find a rough patch on the note than to interpret the dots as a specific character. The tactile feature was not designed for those with very poor tactile sensitivity and acuity, for example, people with peripheral neuropathy resulting from severe diabetes.

Figure 1: Raised-dot tactile feature



Journey series feature denomination numerals on the face and back of the note that are about 30 per cent larger than those of the previous note series (**Figure 2**). The distinct colours used to identify each denomination were also made more vivid to reduce the risk of colour confusion.

It was decided that adopting a combination of accessibility features targeting a range of vision loss could greatly improve the situation.

The Bank also decided to improve the bank note reader, a tool that is especially helpful for blind Canadians living with limited tactile sensitivity (such as that related to diabetes). The bank note reader was given a more ergonomic design and is about half the size and weight of the previous model. It has both tone and vibration output modes (in addition to voice) to address the privacy issue that users had identified and to assist individuals who are deaf/blind.

Figure 2: Improvements in numeral size, font, and contrast



The enlarged numeral is 20 mm in height and is positioned on backgrounds that provide a better contrast. The 20 mm height is estimated to be readable by about 99 per cent of those living with partial vision. The numeral on the front of the note is dark on a pale background, while the numeral on the back is white on a dark background.

The annual cost of the *Canadian Journey* series accessibility program includes the cost of meeting the annual demand for bank note readers (about \$0.15 million)⁷ and the cost of producing the tactile feature (about 3 per cent of the cost of the annual note order). The Bank also funded the development work for the new bank note reader (about \$0.5 million). The enhanced colours and enlarged numerals were incorporated into the bank note design at no added cost.

Assessment of the Accessibility Features in the *Canadian Journey* Note Series

The suite of features and tools introduced for the *Canadian Journey* series was intended to improve the accessibility of bank notes for Canadians living with blindness or low vision. The tactile feature and the bank note reader were aimed at improving access for blind Canadians, while the enhanced colours and enlarged contrasting numerals were intended primarily to help those with partial vision to access information on the notes more readily.

To assess the performance of these features and their impact on those living with limited or no functional vision, the Bank first undertook an informal internal assessment of the tactile feature and later engaged the University of Waterloo to more formally evaluate the suite of accessibility features.

The Bank's own informal assessment of the tactile feature was undertaken about one year after the first denomination in the *Canadian Journey* series was issued. With assistance from CNIB, the Bank obtained feedback from a small group of blind individuals on their ability to detect the tactile feature on a sample of one thousand worn bank notes. The tactile feature was found to be detectable on about two-thirds of the notes. On the remaining one-third, the feature was found to be undetectable owing to the physical wear in the area of the feature and of the overall note.⁸

Expert and user assessment—University of Waterloo

In 2007, about six years after the first note in the *Canadian Journey* series had been issued and prior to starting work on the next series of notes, the Bank

engaged vision experts at the University of Waterloo to evaluate the performance of the entire suite of accessibility features. This assessment involved evaluations not only by experts, but also by Canadians living with blindness or low vision, and included identification of potential areas of improvement for the next note series (Jutai, Strong, and Hovis 2008). The primary objective of the assessment was to determine whether the enhanced accessibility features used in the *Canadian Journey* series provided functional benefits and improved the quality of life for people who are blind or have low vision, related to their ability to conduct financial transactions using bank notes.

The study included an expert evaluation of the suite of accessibility features and tools and an assessment of the impact of the changes in those features on quality of life for blind and partially sighted individuals as they carry out cash transactions.⁹ The research was conducted in consultation with 64 adults, 18 years of age and older: 64 per cent reported that they had low vision, and 36 per cent reported being functionally blind.

Overall, participants noticed all of the changes to the accessibility features and tools in the *Canadian Journey* note series and felt that the changes were beneficial for a range of vision limitations. Not surprisingly, blind participants were more responsive to features that they could touch (raised dots), while those with partial vision were more responsive to the features that improved their visual perception (enhanced colour and enlarged contrasting numerals). Older people (whose tactile sensitivity diminishes with age) were more likely to notice the changes in numeral size and less likely to notice the raised dots. The colour-related changes were noticed equally by individuals with severely impaired colour vision and by those with normal or slightly impaired colour vision.

Changes in the *Canadian Journey* note series were evaluated as having a significant positive impact on major aspects of cash transactions, including recognition, denomination, note orientation, and, to some

⁷ Bank note readers are made available free of charge and distributed by CNIB to blind individuals on behalf of the Bank of Canada.

⁸ Measurements of surface roughness indicated that highly soiled notes had higher overall surface roughness, which could make it more difficult to detect the tactile feature.

⁹ The Psychosocial Impact of Assistive Devices Scale (PIADS) was used to measure the extent to which the accessibility features promote good quality of life for the user: the extent to which they make the user feel competent, confident, and inclined (or motivated) to use bank notes for financial transactions. "Psychosocial" refers to factors within the person and factors attributable to the environment that affect the psychological adjustment of individuals with a disability. "Internal factors (the core dimensions of psychological well-being, which include independence, personal control, self-efficacy, and self-acceptance (Ryff and Singer 1998)) . . . are essential components of how assistive technologies users define the impact of their devices on their quality of life" (Jutai and Day 2002).

extent, authentication. All of the changes, particularly the enlarged numerals, enhanced the ability of those with low vision to recognize and denominate a bank note and to use it, regardless of the note's orientation. The tactile feature improved the ability of blind participants to denominate bank notes. The raised (intaglio) printing found on all Canadian bank notes was also reported to facilitate authentication for blind participants, as well as for those with partial vision, albeit by only a small proportion of participants.

Changes in the Canadian Journey note series were evaluated as having a significant positive impact on major aspects of cash transactions.

The changes in the accessibility features were viewed as having a positive impact on quality of life, although this impact was moderate, since participants felt that the changes made things “just a little bit better” for them. Blind participants tended to give the features more positive ratings than those with low vision, but the difference between the groups was not statistically significant, nor was there a correlation with age or awareness of changes in the features. Scores differed significantly across groups defined in terms of colour vision, however. Those with severe impairment of colour vision reported greater benefit from the changes than those with normal or only slightly impaired colour vision. The changes were felt most in terms of improved functionality and independence.

The impact of circulation wear and tear was also evaluated. Overall, participants felt that their ability to carry out cash transactions was unlikely to be affected by circulation wear. Colour and contrast measurements of new and worn bank notes showed that, although wear and tear produces a “browning” of the notes that reduces the contrast of the numbers, the changes are relatively small. The slight reduction in contrast could be compensated by bringing the note about 5 to 6 cm closer. The objective findings confirmed participant views that normal circulation wear would have only a minor impact on the ability of individuals with low vision to use the notes.

Normal circulation wear had a greater impact on the tactile feature. Although the raised tactile feature is very useful for people with profound vision loss, its usefulness declines as the note becomes worn (a finding consistent with Bank of Canada observations).

Participants described the feature as very effective and highly prized, but they observed that it quickly loses its effectiveness and dependability with modest wear and tear. The most common request of participants was enhancement of the effectiveness and durability of the tactile feature. Nevertheless, some participants stated that even if the tactile feature loses its effectiveness over time, a few months of use is helpful. Some individuals try to avoid this problem by requesting only new notes from their financial institution.

The study also confirmed that the bank note reader was particularly useful for people with profound vision loss. Some users reported concerns, however, especially when trying to read bank notes in poor condition and notes in the *Canadian Journey* series compared with *Birds of Canada* notes. This last point relates to design constraints in the *Canadian Journey* series that resulted in changes that allow notes to be read only when the portrait end of the note is inserted into the reader. Notes in the *Birds* series could be read from either end.

In summary, the University of Waterloo study indicated that the features in the *Canadian Journey* series had improved bank note accessibility for Canadians with a variety of vision limitations. The new accessibility features have significantly increased their ability to conduct cash transactions and have enhanced the quality of life for people with all levels of vision loss. The study recommended that the suite of features be retained for future series of bank notes but that improvements be explored in an effort to optimize them. Specifically, there is a need to increase the durability of the tactile feature and to permit both ends of the note to be read by the bank note reader.

The next generation of bank notes

In light of the Bank's commitment to providing barrier-free access to currency and to continuously improving the quality of Canada's bank notes, this feedback from experts and from Canadians living with blindness and low vision is being considered in the development of the next generation of bank notes. The Bank intends to include reading codes at both ends of notes in the design of the next note series and is also exploring options to improve the durability of the tactile feature—at the same time considering and balancing any trade-offs in security, durability, and cost. Thus, the next series of bank notes is expected to include distinct vivid colours, large contrasting numerals, a more durable tactile feature, and improved functioning of the bank note reader.

Conclusions

The Bank of Canada's approach to providing accessible bank notes for Canadians who are blind or have low vision reflects the Bank's commitment to providing barrier-free access to currency. The goal of bank note design and development is, as always, to provide all Canadians with bank notes that are secure, readily accepted, and that can be confidently used to carry out cash transactions. The Bank's objective is that the final bank note design reflects a combination of features and materials that meet the Bank's key performance criteria and also meet the needs of a wide variety of bank note user groups. The development of Canadian bank notes is based on a proactive and effective process of continuous improvement that relies on scientific and empirical research, together with direct feedback from bank note user groups and experts. The cycle is non-stop and clearly focused on the Bank's objectives. Features in the current note series are evaluated, opportunities for improvement are identified, needs are defined, and potential solutions are developed and tested.

Relationships and partnerships with both bank note user groups and experts are important to the Bank and are critical for success. By working closely with its stakeholders, the Bank obtains key information about which features are working well and where opportunities for improvement exist. In some cases,

this work leads to collaboration in research and development that helps the Bank to formulate the best solutions in the most effective manner—critical from a public policy perspective.

Relationships and partnerships with both bank note user groups and experts are important to the Bank and are critical for success.

The Bank's experience with the accessibility features in its current note series suggests that while bank note experts can balance the needs of various user groups with the technical limitations of notes (size, printing technology, durability, ability to provide a tactile sensation), it is people living with vision loss, as well as experts who study that loss, who are best positioned to define their specific needs. The Bank has been pleased with the positive feedback from Canadians living with blindness or low vision and has been consulted by several other central banks that wish to learn from our experience, while developing solutions to serve their own communities.

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