MONETARY POLICY AND TRANSMISSION MECHANISMS IN CHILE: HAS THE EFFECT OF MONETARY POLICY CHANGED IN TIME? WHY?

Verónica Mies[*]
Matías Tapia[**]

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Abstract

Is an increase in the real effect of monetary policy shocks a desirable development? The first part of the paper reviews traditional monetary transmission mechanisms in the light of their relation to effectiveness and market distortions. Second, we study the output effects of monetary surprises using panel data for 20 countries between 1960 and 2000, accounting for the determinants that determine this relationship. As expected, variables such as the level of inflation volatility diminish the impact of monetary shocks. Third, we focus in the Chilean case. VAR models are used to analyze the temporal development of impulse-response functions. Results suggest that monetary policy effectiveness in Chile has changed during the last decade. Finally, we study empirically what are the macroeconomic developments behind such evolution.

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[*] Economic Research Department, Central Bank of Chile. E-mail: vmiesm@bcentral.cl
[**] Economic Research Department, Central Bank of Chile. E-mail: mtapia@bcentral.cl

I- INTRODUCTION

The potential impact of monetary policy on the economy - and the channels through which it operates — has been at the core of macroeconomic discussion for decades. However, besides agreement on basic issues such as the long-run neutrality of money, no clear consensus has been achieved. A number of arguments have been proposed — particular or general, complementary or contradictory— to explain how monetary policy decisions could be transmitted to prices and to the real sector (Lucas, 1972; Taylor, 1979; Ball, Mankiw, and Romer, 1988), as well as to describe the intensity and efficiency of this transmission.

The main issue on the debate regarding monetary transmission is its potential association to short-term real effects. If such a dimension were absent, the dichotomy between nominal and real variables would reduce the macroeconomic stability objective sought by the monetary authority to the search of a strategy to ensure stability of prices. However, either because of information asymmetries (Lucas, 1972), adjustment costs (Mankiw, 1985) or price stickiness in key markets (Taylor, 1979), the actions of the monetary authority eventually have real effects in the short run.[1] This does not prevent the policymakers' main goal from being a nominal one, i.e. price stability, but it give space to complement the attainment of such objective with an orientation to smooth the business cycle, especially when the nominal goal has already been accomplished.[2]

In that sense, it is interesting to examine whether monetary policy can affect the real sector. This can be measured in at least two dimensions. First, the absolute magnitude of the impact, a concept we here identify with "effectiveness". Monetary policy will be "effective"[3] if the elasticity of output to policy movements is different from zero in the short-run. Second, the relative magnitude of such effect compared to the effect on prices, the "sacrifice ratio". This second dimension, describing the trade-off faced by policymakers when dealing simultaneously with output and inflation, is directly linked to the policy dilemmas associated to the presence of relationships between output and inflation.[4] In addition, attention must be given to potential interactions between both variables (output and inflation) and between the effects of specific monetary actions upon them.

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[1] Even if monetary policy has the potential of affecting real variables it does not mean that dong so is a good thing to do from a welfare perspective. This can be seen reflected in the various –differing- policy prescriptions derived from alternative aggregate supply models, from the passive stance suggested by neoclassical models to the activism recommended in a neokeynesian framework.

[2] Coinciding with the above, this paper does not evaluate the optimality of conducting an active monetary policy. Rather, taking the conduction of active monetary policy as a practice worldwide, it analyzes the channels through which monetary decisions affect the economy, with a special emphasis on real effects.

[3] But not necessarily efficient.

[4] For common utility function with output and inflation deviations as its arguments, the authority would prefer the economy to have different sacrifice ratios at different points in the cycle. With high inflation, a "low" sacrifice ratio would permit them to apply a contractionary policy capable of reducing inflation without a major effect on output. Within a recessionary context, policymakers would prefer the economy to have a "high" sacrifice ratio, with an expansionary monetary policy having a strong impact on output without a major increase in inflation.

Given that most countries choose to operate with active monetary management, an adequate conduction critically requires significant clarity on the potential effects on the economy, including specific information on magnitudes, time lags, and the relevant channels in action. This knowledge, however, would prove itself useless if taken as static. As suggested by the Lucas critique, the parameters through which specific policies affect the economy change not only because of exogenous changes in their structural determinants, but also endogenously to the way policies are managed. Thus, a dynamic vision—under constant revision— of monetary transmission becomes necessary, which recognizes the impact of structural changes, including technological, institutional or policy-related changes. Understanding that monetary policy transmission is not a stable function in time has two main consequences. First, it implies that the conduct of monetary policy is no trivial exercise and—if its active implementation is pursued—it cannot be a purely mechanic exercise based on the observation of historic behavior or the repetition of strategies deemed as successful in the past. Second, and given the above, it suggests that the success of monetary management critically depends on the ability of policymakers to identify the changes in the parameters associated to transmission, and to adjust their monetary frameworks accordingly.

An obvious, but generally overlooked issue in the policymakers' discussion of monetary policy, is the fact that transmission mechanisms depend—for a significant part—on market imperfections. These imperfections range from the primary effects of short-run monetary policy on real market interest rates at various time terms (the starting point of virtually every mechanism described herein) to the information asymmetries among economic agents that play a crucial role in the so-called credit channel. In an economy with instantaneous price adjustment, perfect information and complete financial markets, monetary policy would be neutral even in the short run, playing no other role than determining the inflation rate and, through it, the demand for real monetary balances. In such a scenario, altering the structure of the economy to increase the "effectiveness" of monetary policy would be absurd from a welfare perspective.

In that sense, an increase in the capacity of monetary policy to affect the real sector, for a given economic structure and its associated degree of effectiveness, is not necessarily desirable, even if monetary actions are optimally conducted. With the same logic, observing a diminishment on the central bank's capacity to affect the economy may not be worrisome, but an indication that the economy's overall structure is becoming more efficient and flexible.

For example, the success of monetary policy in smoothing the adjustment of a credit-constrained economy to an adverse demand shock is a second-best solution, since the first best would probably be to have a more complete financial market and the economy adjusting automatically. The lost of monetary "effectiveness" would be a desirable outcome if it is the result of phenomena such as increased financial development, better information systems or more flexible contracts.

Section II performs a brief critical review of each transmission mechanism from an analytical perspective. Such a review does not intend to be exhaustive, but rather to illustrate the main elements involved in each of the channels mentioned therein. Sections III and IV provide new evidence for Chile case. The paper contributes to Chilean evidence by undertaking two subjects that have been overlooked in previous research, namely i) the evolution of the impact of monetary policy on output and inflation during the past decade,

II- TRANSMISSION MECHANISMS: THEORETICAL ASPECTS

Providing an exhaustive review of the literature on monetary transmission goes beyond the scope of this paper, as such an effort has been done elsewhere repeatedly and abundantly. Instead, our attention will be placed on a brief review of the underlying assumptions of the most traditional transmission mechanisms, and their implications for the evolution of monetary effectiveness.

The first fact regarding the "channels" of monetary transmission is that they are not independent mechanisms, but rather simultaneous—and occasionally complementary—processes. However, this simultaneity has not been correctly assessed by the literature. In fact, its main theoretical and empirical shortcoming is that it lacks an analytical scheme able to encompass, in detail, the various transmission mechanisms. Transmission channels are normally undertaken independently, either through theoretical models that focus on one of them in particular, or through empirical studies derived from those models. "Aggregate" empirical studies, on the impact of interest rates on output and inflation are, actually, a hybrid between the most common transmission channel (i.e. monetary policy rates to market interest rates, to consumption and investment decisions, to economic activity and inflation) and the net effect of all the mechanisms, without determining the weight of each one.

1. The traditional transmission channel: the direct effect of the interest rate

This is the most conventional mechanism and, at the same time, the one used in empirical studies to embody the joint effect of all the channels. It is the mechanism that underlies public intuition and media debates on the role played by monetary policy in modern economies. It combines the central bank's ability to affect a real variable (the interest rate) and the existence of an inter-temporal substitution elasticity on the components of aggregate demand.

The central bank induces—through variations of the amount of money[5]—changes in the nominal interest rate that, because of the presence of stickiness or imperfections in the economy's adjustment mechanisms, translate into variations in the real interest rate.

[5] Through open market operations that may have as their operative target a very short term interest rate, such as the interbank overnight rate.

The shift in the real interest rate impacts consumption and investment (including inventory) and, hence, the output level and prices. The effectiveness of monetary policy will depend not only on its ability to affect the real interest rate, but also on the sensitivity of consumption and investment to changes in the price of intertemporal substitution. The elasticity of aggregate demand to the interest rate—both absolute and relative—will determine how, when, and to what extent the monetary policy will affect the economy. Furthermore, the increase in the interest rate might not only have a substitution effect that discourages investment and consumption, but could also create wealth effects depending on the borrowing or lending position of economic agents.[6]

This basic model, however, would only be complete if the economy's financial portfolio consisted solely on bonds and money, with no other assets available to agents. If a richer economic structure is recognized, the economy does not then there is no longer a single interest rate, so the direct effect of policy actions on consumption and investment fades[7]. Monetary policy will be more effective the more it can affect, by managing a (very) short-term interest rate, the whole structure of interest rates, particularly the longer-term ones, those most relevant for decisions on investment and consumption of durables.

One traditional assumption, derived from an arbitrage condition, is the long-term rate being a weighted average of expected short-term rates (Kamin, Turner, and Van Dack, 1998). The propagation of policy actions throughout the whole structure of interest rates will depend on factors such as the financial markets' structure—which do not exist explicitly in the basic model—and to expectations. Both factors can be labeled, thus, as transmission channels in themselves, interacting with the more general mechanism. For example, in an underdeveloped financial market, the monetary authorities' control (direct or indirect) on the interest rates of other instruments can be large, thereby aiding the transmission of their policy decisions. The market can also interpret current interest rate movements as a signal of future monetary policy actions, making longer term rates react consistently. A decline in interest rates, for example, can be construed as a factor that will raise future inflation. Since a contractionary monetary policy is expected to offset such an increase in inflation, long term rates may end up increasing as a reflection of the expected increase in the future policy rate.

As aforesaid, the basic model does not consider financial intermediation. It describes an economy with no banks, where borrowers and lenders exchange their resources directly. Therefore, a rise in the interest rate caused by a monetary contraction will result in discarding only those investment or consumption projects whose expected return, adjusting by risk, is lower than its financing cost. In this sense, no inefficiencies exist in the way investment or consumption contracts, as opposed to the credit mechanism

[6] If it is a closed economy, its net position is obviously zero. This does not mean that no wealth effect exists on the aggregate, if the utility functions of individual agents differ from one another.

[7] Although financial prices will be arbitraged (this is, all rates and prices are endogenous), the Central Bank will lose power if the rate it manages does not anchor the rest of the economy's prices, but is caused by them.

analyzed below (Cecchetti, 1999).[8] Resources are assigned efficiently at the given interest rate.

Another dimension, which is relevant for the all transmission mechanisms described herein, is the source of the market imperfection that generates the real effect of the nominal policy change. Be it some price/wage rigidity in the neokeynesian tradition, or an information problem as suggested by a Lucas-type supply function, one can expect that – if agents are rational - the "real" effect of a monetary shock is smaller (or non-existent) in unstable economies. This, either because agents have incentives to adjust/revise their contracts and prices at higher frequencies (the neokeynesian interpretation) or because price signals are no longer reliable (the Lucas interpretation). This is, the short-run Phillips curve can become vertical in a context of macroeconomic instability. For instance, economies in which inflation is more volatile should be associated – ceteris paribus – to smaller output effects of a given monetary shock.[9]

2- The assets channel

This channel, as indicated by its name, extends the previous analysis recognizing the existence of a wider array of assets, beyond the simple structure of bonds and money of the traditional transmission mechanism. One particular case is the monetarist vision, summarized by Meltzer (1995), which states that the attention paid to the interest rate overlooks the role of the amount of money in (potentially) influencing wealth.

More generally, monetary policy potentially impacts not only the interest rate, but also a large number of asset prices. This generates additional wealth and substitution effects that, typically, strengthen the direct effect of policy interest rate movements on consumption, investment, and labor. Thus, a slight change in monetary policy may have significant effects on economic activity through its impact on the value of an asset with high weight in the overall asset portfolio.

Typically, asset prices should decline as a result from a monetary contraction, either by direct substitution effect (e.g. a reduced relative return of interest rates) or by a contraction in demand. As before, the intensity of this mechanism will depend of the role played by other channels: the sensitivity of the price of any given asset depends on the

[8] There is vast empirical evidence on this channel—in particular from an aggregate perspective—although it is inconclusive regarding the magnitude or even the significance of the impact. Great heterogeneity of results is observed between countries, or for the same country at different moments. See, among many others, the studies for the United States by Cagan (1972), Melvin (1983), Romer and Romer (1994), Bernanke and Mihov (1995), Christiano (1995), Christiano, Eichembaum and Evans (1996). Mojon and Peersman (2001) and Taylor (1995) that present data for European countries and review existing evidence. Bravo and García (2002) make a good summary of VAR studies for various countries. Schmidt-Hebbel and Tapia (2002) present the significant differences in implicit responses in the models used by central banks operating under inflation targeting regimes.

[9] The answer is less clear regarding the inflation level, as it does not affect the size of the impact of monetary shocks in Lucas' framework.

sensitivity of its expected future flows on current and expected monetary policy. The structure of the financial market, and the variety of investment and credit options available to agents, will determine the magnitude of the contraction of the demand for a given asset, and the ultimate elasticity of its price with respect to the policy decision.

The logic, based on simple arbitrage conditions, is straightforward. For example, stock prices should rise with a monetary expansion, because they become comparatively more appealing than fixed income instruments. This increase in stock prices, in the line of Tobin's q theory, raises investment, as it becomes profitable for firms to devote their resources to expand their capital. The change in the price of shares also has a wealth effect on firms (by increasing their market capitalization) and households (by increasing the value of their portfolios). For firms, the improvement in their balance sheets—within a context of financial intermediation with asymmetrical information— increases their access to credits and their investment possibilities. For households, higher wealth implies a higher permanent income, thus raising consumption (Mishkin, 2001). In addition, the change in stock prices should provoke a liquidity effect on households: an increase in the value of the liquid component of households' portfolios will reduce liquidity risk exposure, so they can increase their demand for non-liquid assets such as real estate properties and durable goods.

A similar story can be applied to real estate. Monetary expansion reduces the cost of real estate financing, thus increasing the demand for properties and the net income of firms engaged in this activity. Because real estate is a very important component of households' asset portfolio, the wealth effect on these will be significant. Also, the effect will be strengthened through the credit channel, through an increase in bank credit availability resulting from the increased of collateral value (Kiyotaki and Moore, 1998).

Thus, the effects of monetary policy through this channel should be greater in economies where the share of the agents' wealth portfolio invested in assets that are sensitive to monetary policy changes is greater. In that sense, one could expect to see a higher impact of monetary policy through this channel if, for example, the importance of the stock market is greater[10].

Clearly, for all these effects to have a real impact, the response of different assets' prices must differ. If all prices changed the same, relative prices would remain unaltered, the only variation being a shift in the economy's' nominal scale. No effect whatsoever would occur on the agents' real wealth (nominal wealth increasing by the same proportion as the general price level) or in relative incentives, and no shifts in portfolio, consumption or investment would be observed. Thus, once again some type of "market imperfection" is required[11].

3- The exchange rate channel

[10] However, and as discussed below, the relative importance of the stock market can diminish the impact of monetary policy through other channels.

[11] To review international empirical evidence on this channel, see Koenig (1990), Bomhoff (1993), Borio *et al*. (1994), and Meltzer (1999).

Strictly speaking, this channel is a particular case of the assets channel, since it is the price of a particular financial asset, namely another country's currency. However, because of its widespread impact as one the economy's most important relative prices, and its direct effect on inflation through the prices of tradable goods, it is worth treating it as a separate channel.

If the exchange rate is not fixed,[12] its behavior should depend on the behavior of the domestic interest relative to the foreign rate. The exact impact of a change in the policy rate is uncertain, because it depends—again—on the expectations on the interest rates and on domestic and foreign inflation. However, ceteris paribus, an unexpected increase in the domestic interest rate appreciates the local currency on impact. The exchange rate must move to a level where investors expect a sufficiently large future depreciation so that the expected returns of domestic and foreign deposits become equal. The result is an instant appreciation of the exchange rate. The greater value of the local currency increases the price of the country's goods in terms of foreign assets, thereby causing a drop in net exports and in aggregate demand. In addition, the exchange rate directly affects inflation through imported goods. A contractionary monetary policy, leading to a currency appreciation, will reduce the imported component of inflation.

The opposite process, i.e. the devaluation of the currency with an expansionary effect on exports and the overall level of activity, has been termed "competitive depreciation" and has been traditionally advocated as a quick adjustment mechanism that prevents—within a context of price stickiness—a big rise in unemployment when facing an adverse shock.

In practice, however, the uncovered interest parity, that underlies the expected relationship between domestic interest rate movements and exchange rate depreciation, has received scarce empirical support. The short-run behavior of the exchange rate appears to be extremely volatile, and expectations regarding its movements are closely related to the expected evolution of inflation.

The second mechanism through which the exchange rate operates depends, once again, on the financial market's depth and completeness, specifically regarding the set of hedging instruments it offers. If firms have currency mismatches between their assets and liabilities and no currency hedging is available, are unable to hedge, their balance sheets become sensitive to abrupt exchange rate fluctuations. If local residents are net debtors, as is the case in many emerging economies, a substantial appreciation of the exchange rate improves their balance sheet position, eventually leading to a significant domestic demand expansion, offsetting or even outweighing the effect of relative prices.

A couple of final considerations are worth mentioning. First, the direct impact of monetary policy – a nominal exercise – is on the nominal exchange rate. If the purchasing power parity held at any given time, no changes on relative prices or balance sheet effects would exist. For example, the increase in the foreign currency denominated debt would be

[12] This is a requisite for running an independent monetary policy in the absence of effective capital controls.

offset by its liquation upon its translation into domestic money. Only if the central bank's actions are able to change the real exchange rate, this would be associated to effects distinct to the obvious impact on inflation. The determinants of this transmission will be similar to those of any nominal shock to prices, such as the economy's competitive structure, inflation level and variance, and the like (see, for example, McCarthy, 2000).

The second consideration was already mentioned, and refers to the poor predictive power of exchange rate models. The logic of this transmission mechanism is consistent with a vision of relative money demands, where the exchange rate depends on interest rates, relative money stocks and the relative output levels. However, this approach has been questioned by empirical evidence, given the feeble predictive power of traditional models, even when taking the effective values of the right-hand variables (Flood and Rose, 1999). Cheung, Chinn and Pascual (2002), and Meese and Rogoff (1983), using a large batch of economic models and econometric techniques, find no model to be consistently superior, in terms of forecasts, to a simple random walk. As aforesaid, the same occurs with arbitrage equations derived from this approach, such as the uncovered interest rate parity. This, combined with the high ("excessive") volatility observed in free-floating countries, turns the relationship between monetary policy and the exchange rate channel not so linear and univocal as might be thought of *a priori*. Relying on the exchange rate as the tool to control inflation or reallocate real resources can turn out as an extremely uncertain bet.[13]

As with the asset channel, some specific features present in different economies could indicate varying degrees of importance of this mechanism. Countries with higher exchange rate flexibility, in which the exchange rate has more space to adjust in response to a specific policy shock[14], could exhibit greater nominal (real) exchange rate variations after a change in monetary shocks. Similarlly, a given change in the exchange rate (caused by a monetary policy action) should have greater impact on economies more open to international trade, for which the exchange rate is a relevant price for a larger set of goods.

4- The credit channel

The traditional transmission model rules out the existence of the financial sector. Every profitable project at the prevailing interest rate is undertaken. Thus, and as stated by Modigliani and Miller (1958), the source of financing does not matter for the firm to make its (investment) decisions. Resources are always allocated efficiently. In a context of

[13] The experiences of recent years, including significant devaluations in Chile and Brazil that have not affected inflation, raise doubts on the role of this channel in transmitting inflation. Although there is abundant theoretical literature on this matter (e.g. Dornbusch, 1997, and Goldberg and Knetter, 1997) empirical evidence is scarce, except for some studies on specific countries or regions (Amitrano *et al.* 1997). Goldfjan and Werlang (2000) examine the relationship between exchange rate depreciation and inflation in 71 countries, for the 1980-1998 period. The main determinants of pass-through are found to be the economy's cyclical position, the real over- (under-) appreciation, the rate of initial inflation and the degree of openness of the economy. For developing countries, the real exchange rate's misalignment seems to be the great determinant of pass-through to inflation; in developed countries, this role is played by the level of initial inflation.

[14] An in which there is more space for independent monetary management in the first place.

symmetrical information and no transaction costs, financial intermediation serves no purpose and thus no resources are devoted to it.

Nonetheless, financial intermediaries—particularly banks—exist as the economy's efficient response to information asymmetries between lenders and borrowers, its associated transaction and monitoring costs, and the presence of liquidity risks.

Because financial intermediaries exist in a world with multiple financial instruments, at least two sources of financing must be recognized for firms. First, external or intermediated funds, where the firm accesses the financial market, but does not trade directly with individual investors, receiving their funds through an intermediary (bank loans). The second source are internal/direct funds, in which the firm either finances itself, without accessing the financial market, or is able to raise fund directly from individual investors (through the issue of bonds or stocks).

The problem is that the second source, assumed implicitly in the traditional mechanism, can be restricted (totally or partially) for a significant number of firms. If so, the fall in investment may not depend, as in the traditional channel, on the project's profitability—relative to its alternative costs—but rather on the firm's access to bank credit.

Two mechanisms have been proposed to explain the link between monetary policy actions and this cost, namely the balance sheet channel and the bank lending channel. This tries to separate the effects on the firms' borrowing capacity from the amount of credit offered by the banks. Both rely on a market imperfection, which conditions access to the financial market on the firm's characteristics, rather than on the profitability of its investment projects.

4.1 – The balance sheet channel

This channel reflects a direct implication of the asset channel. The value of a firm depends on both its expected future flows and the value of its assets. Both components can be affected by the interest rate through the channels described earlier. The market value of firms can drop after a monetary contraction. The balance sheet represents the collateral with which the firm negotiates lending conditions with the banking system. A decline in the firm's capital value increases its incentive to undertake risky projects, because of the reduction in the share of own resources involved in them. This moral hazard will result in an adverse selection problem in the demand for credit—firms whose capital has been reduced more heavily will present the riskiest projects to banks. This would not pose a problem as long as information was perfect: banks could correctly assess the firms risk and robustness, discriminating and charging them accordingly. However, because information is asymmetrical between the firm and the bank on the projects' actual return, will end up pushing the banks to increase the premium imposed on the funds, and eventually ruling out the firm's access to credit. "Good" firms may not be distinguished from "bad" firms.

Being restricted in their access to banks would not be a problem, unless other sources of financing are closed, mainly because of the reasons that cut bank financing in the first place. The reduction in its cash flows—resulting from the monetary contraction—may prevent internal funding, while direct funding from individual investors might be constrained if the monitoring cost associated to asymmetric information is too high for individual lenders—economies of scale in such cost is one of the reasons why banks exist (Bernanke, Gertler and Gilchrist, 1998; Kiyotaki and Moore, 1997).

Such situation, i.e. dependence on a banking system that is increasingly costly, should be larger on firms where the information asymmetries are more severe—typically small or new firms—and in the context of less developed or comparatively more shallow financial markets. Thus, contractionary monetary could be more ”effective” in countries with relatively underdeveloped financial systems, or where information standards are poor.

Interestingly, this channel permits to explain longer lasting effects of monetary contractions than suggested by the elasticity of consumption and investment. In effect, the capital situation of firms that must pay a higher risk premium—or that are directly left out of the credit market—will only worsen in such conditions, aggravating the problems of moral hazard and adverse selection described above. This channel also involves responses to the interest rate that are non linear and asymmetrical: a small monetary contraction can affect—marginally—a significant number of firms, causing a much stronger—and lasting—impact on the level of activity than would result merely from consumption and investment elasticity. The asymmetry is clear: an interest rate reduction that follows a large contraction will not necessarily be matched by an equivalent increase in activity, if the firms' financial situation was too affected by the first contraction.[15]

4.2- The bank lending channel

The flip side of the coin is what occurs with banks and their credit supply. The mechanism recently described suggested that the firms' deteriorated equity position affected their viability as bank borrowers, their main source of fund raising. But what happens from the perspective of credit suppliers? Typically, a monetary contraction will result in reduced bank reserves, causing an increase in the marginal cost of lending (Bernanke and Blinder, 1988).[16] This will reduce the supply of funds from the banking system, either in the form of a leftward movement of the curve or, directly, as a contraction of the amount of credit (Stiglitz and Weiss, 1981). This will—similarly to restrictions suffered by firms as borrowers—affect with greater strength those firms that, because of their own characteristics and those of the banking system structure, depend heavily on this type of financing.

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[15] What does the empirical evidence show? Gertler and Gilchrist (1993, 1994), Carpenter, Fazzari and Petersen (1994), Zakrajsek (1995), Christiano, Eichenbaum, and Evans (1996) and Domac and Ferri (1999) find evidence of asymmetries in the responses of large and small firms to a monetary shock, depending on their access to various sources of financing.

[16] Strictly, what we have is an increasing marginal cost of procuring external funds to lend. This is a necessary requisite to constrain credit in a competitive banking industry. (Bernanke and Blinder, 1988; Kashyap and Stein, 1994).

Alternatively, this credit channel can operate even if the marginal cost of financing new loans remains constant. This will be possible in the context of a non-perfectly competitive banking industry, where banks grant loans for an interest rate that exceeds the cost of finding these resources.[17] [18]

All the above effects should not only cause asymmetrical responses between firms, relative to their dependence on the banking industry as a source of financing, but also affect bank behavior. The characteristics of the banking system will be important, such as its degree of competition, access to external resources (within and outside the country), the role of state-owned banks and any financing networks that may exist between these financial institutions. According to Kashyap and Stein (1994), the smaller banks—as it occurs with small firms—should contract their credit supply more.[19]

One interesting conceptual derivation of this channel is Cecchetti's (1999), that links the power of monetary policy with the institutional characteristics of the financial system—particularly the legal system that supports it, and the relative incentive it gives banks *vis a vis* direct financing. The idea is that those countries with better protection and information standards go more to direct financing, and thus monetary policy is less effective on them.

To sum up, the credit channel approach is interesting for a number of reasons. First, if it is correct, monetary policy can affect the real economy without having to effect any material change in the market interest rate, in addition to producing a hysteresis that may extend such effects over time.[20] Second, this channel permits to analyze the way in which innovations in financial institutions can affect the strength of monetary policy. Third, this approach permits to examine the distributive effects of monetary policy among lenders and borrowers (contrary to the traditional interest rate approach). Fourth, the credit channel

[17] Chami and Cosimano (2001).

[18] Given that the financial sector—because of asymmetry problems and liquidity risks between intermediaries and depositors—is subject to regulations, it is worth questioning to what extent such regulations can affect transmission. Is the banks' credit supply, or the restrictions faced by borrowers, affected by regulations on such aspects as the capital of banking institutions? The answer to this is unclear, and depends on two basic elements (Freixas and Rochet, 1997). The first is the way in which regulation[18] affects bank capital. If capital is strengthened, the bank will be less sensitive to adverse shocks such as a monetary contraction. However, its willingness to take risks will also be affected. This second effect has an unclear sign. While some authors state that the increase in financial soundness makes banks take higher risks and thus increase their loan supply (Koehn and Santomero, 1980; Froot and Stein, 1998), others (Chami and Cosimano, 2001) believe that the banks' optimal response includes restricting credit—or orienting their investors toward safer assets—in order to minimize the probability of the capital contraction being operative.

[19] There is abundant evidence on the empirical relationship between monetary policy, bank loans and economic activity, which seems to back the theory. See, among others, articles by Bernanke and Blinder (1992), Kashyap, Stein, and Wilcox (1993), Ferri and Tae Soo Kang (1999), Kashyap and Stein (2000), and Ehrmann *et al*. (2001).

[20] This channel may be activated in a ruler-type scheme (S,s).

explains how monetary contraction influences the behavior of investment and inventories in large and small firms.

This channel opens a new dimension for monetary policy effectiveness, potentially costly in terms of aggregate efficiency. The desired contraction does not happen, as would suggest a Modigliani and Miller style world, that is, only for low return projects, but also for other projects because of characteristics not necessarily related to the quality of investment alternatives, such as size or information availability. This might cause the economy to drift far apart from an efficient allocation of resources.

In that sense, this channel is maybe the best example of how deteriorated policy effectiveness can be associated to processes that improve the economy's aggregate welfare. This, not because monetary policy is bad in itself, but because its power is based on a severe imperfection that distorts the correct operation of the market. Observing huge "effectiveness" after contracting the monetary stance might not be a matter of celebration for policymakers, but a source of concern for the costly effects of resource misallocation.

All other things being equal, monetary policy will be more effective in a country whose financial market is more constrained, where firms have no alternative funding sources because of lack of markets[21] or poor information. Developing the financial market, translated into increased levels of information and greater availability of instruments should lead to better resource allocation. Any decline in the effectiveness of the monetary policy that comes as a consequence of such process will be of second order in terms of welfare.

5- Expectations of economic agents

As expectations play a key role in all the remaining channels, labeling them as a channel by themselves could be somehow confusing. Any intertemporal model, with agents placing some value on future events, must define how these agents generate expectations, how important these are for policy management. However, expectations are so central to monetary transmission that they deserve to be analyzed in detail by themselves.

Assuming rational expectations, the precise effect of a policy change on expectations can vary at different points in time or in the business cycle. The market's response will depend on the external and internal environments and on the policy regime, all variables that vary in time and that are partially endogenous. The uncertainty on the impact of the policy change on the economy enhances the need for a credible and transparent regime.

[21] Note how this effect contradicts the one associated to the assets channel, which suggested that the stock market development could augment the impact of monetary policy.

Central bank credibility will play a leading role, permitting agents to evaluate more clearly the consistency of a specific policy decision. With a credible inflation target, for example, monetary policy will be anchored to the target in the medium term, allowing agents to generate a clearer and less erratic expectation of the future behavior of the policy rate, and diminishing the impact of temporary disturbances that are likely to reverse in the future. If the nominal objective is credible, the term structure associated to a reduction in the policy rate, for example, must be consistent with the fact that future expected policy rates—that partially determine long-term interest rates today—reflect compliance with the policy goal. If, on the contrary, the target is not credible or—more generally—there is no clarity on the central bank's objective, the effect on the rate structure will be more ambiguous. The market shall infer future policy actions by looking at the currently available information.[22] Thus, the impact of a policy decision today on the global rate structure of the economy should be more predictable—with a given financial structure—the greater is the degree of credibility in the goals of the central bank.[23]

As monetary policy becomes more transparent and believable, the market should be more certain and clear about the determinants of central bank decisions. This allows for the use of instruments other than interest rates, such as announcing policies or targets. If these are credible, monetary policy can be effective merely because of its potential to act actively through interest rates. In general, this credibility may suffice to accomplish the desired effect of monetary policy, by changing the way expectations are determined in the economy. This channel is especially important for the success of inflation control programs, and for implementing regimes such as inflation targeting. In that sense, communication between the central bank and the public, as well as the overall transparency of the country's monetary policy, will play a fundamental role.

Notice, however, that the specific relationship between transparency and monetary effectiveness (understood, again, as the capacity to attain a real effect) is not clear-cut from a theoretical perspective. If monetary policy is capable of affecting the economy solely through surprises, higher transparency – in which monetary policy becomes more predictable – could reduce the space for surprises, and thus for the existence of real effects. If, conversely, the monetary policy has effects because of a rigidity of the economy's price setting structure, the case to maximize the benefits through the more transparent transmission channel looks clear. In our opinion, two things can ultimately tilt the scale in favor of increasing transparency from the monetary policymaking standpoint: first, that in practice it is very difficult to figure out if actual effects are due to asymmetric information, sticky prices, or some combination of the two (and in what proportion). In doubt, the evaluation tends to favor increased transparency on the basis that the cost of being wrong seems lower in the case of being transparent and the effectiveness of the policy being due

[22] If, in the extreme, the central bank has no nominal objective, any nominal rate structure would be possible because of the economy's lack of anchor.

[23] It is true that, even if the central bank's objective is credible, the perceived present policy with respect to the future (i.e. how expansionary or contractionary the present policy is believed to be) will depend not only on expectations about different macroeconomic variables, but on the perceived neutral policy rate (and the associated potential output).

to asymmetric information, than in the case that there is little transparency and what prevails is price stickiness. The second reason to prefer more transparency lies in the possible existence of dynamic inconsistency. Transparency, in a repeated game, can play the part of a compromise that helps to quit the dynamically consistent but sub-optimal solution and come closer to a Ramsey-type one. Transparency enhances monetary discipline, reducing the extent for irresponsibility in monetary management.

III- Empirical evidence

III.A- International evidence

The purpose of this paper is to track the evolution of the effects of monetary shocks, and to analyze what are the determinants of those effects. In particular, accounting for changes in transmission mechanisms and in overall macroeconomic conditions.

As a first approach to this issue, we focus on international data. This allows us to make a broad assessment of our main hypotheses, as well as presenting the methodology that is later used for the case of Chile.

To do so, we gather quarterly data for 29 countries, both industrialized and developing, between 1990 and 2002[24]. All data is obtained from IFS. Observations with high inflation, or in periods with fixed exchange rates, are dropped from the sample. For each of these countries, the following variables are included: 4-quarter CPI inflation, inflation volatility[25] the output gap (as deviation from the Hodrick-Prescott filtered series), the "world output" gap (as deviation from the Hodrick-Prescott filtered series), openness (the sum of exports and imports as a share of GDP), and a measure of financial depth (rolling 4-quarters average M2 as a share of GDP).

Our strategy is as follows. As discussed earlier, the focus of the paper is on the effect of non-systematic, unanticipated monetary shocks. Where are these shocks obtained from? From the estimation of Taylor rules that attempt to capture the "systematic" management of monetary policy. Residuals from those equations are identified as non-systematic monetary shocks.

The second part of the empirical procedure estimates the effects of those shocks on the output gap. However, our interest is not only on the coefficient associated to the monetary shock in the output gap regression, but on the determinants of that coefficient.

This is illustrated by equations (1) and (2). Equation (1) is the equation for the output gap, which is a function of the vector macroeconomic variables X (its own lags, the world's economy cyclic position, the price of oil) and of monetary policy shocks (the residuals from the Taylor rule equations). The parameter β measures the impact that the monetary shock has on the output gap (we only consider a contemporary effect). Equation (2) is an

[24]

[25] Defined as the rolling 8-quarter standard deviation of inflation rates.

equation for the determinants of that parameter, which is function of a set of variables (H) whose potential importance can be derived from the discussion of transmission mechanisms presented above. We estimate equations (1) and (2) simultaneously, with a non-linear equation which includes what we identify as relevant variables for the impact of monetary shocks on output.

$$(1)\quad (y_t - y_t^*) = \mathrm{A}X_{t-n} + \beta_t r_t^{shock} + \upsilon_t$$

$$(2)\quad \beta_t = \delta + C\mathrm{H}_t$$

In particular, the variables used as potential determinants of monetary transmission are:

- Inflation volatility, to measure the extent of macroeconomic stability. According to theory, monetary shocks should have greater effects in stable countries, as suggested either in Lucas-type supply models or in neokeynesian framework.
- Financial depth: This provides a broad description of the financial sector. In principle, higher financial depth should be associated to smaller effects of monetary policy, as the central bank has a smaller influence on financial prices and sources of funding.
- Trade openness: The effect of this variable can be considered ambiguous, as it could be associated to greater real effects through the exchange rate channel, but could also imply more competitive markets, with higher price flexibility.

Taylor rules are estimated between 1990 and 2002, using Seemingly Unrelated Regressions and fixed effects. The country's policy interest rate is regressed in its lag, a trend, the output gap and the level of inflation gap. All coefficients are country specific (the estimated Taylor rule is presented in the appendix).

Once the residuals from the Taylor equations are obtained, they are included in equation (3):

$$(3)\quad (y_t - y_t^*) = \mathrm{A}X_{t-n} + (\delta + C\mathrm{H}_t)_t r_t^{shock} + \upsilon_t$$

, which is the combination of equations (1) and (2) presented above, .

Table 1 presents the results of the estimation of equation (3). The estimation was performed using GLS with random effects. Table 1 presents a specification with the lagged output gap as a control., and the three determinants of monetary shocks included in a non-linear fashion. As expected, the sign associated to inflation volatility is positive, suggesting that higher macroeconomic unstability diminishes the contractionary effects of an unexpected increase in interest rates. The coefficient associated to financial depth is also positive: monetary policy appears to be less effective in countries with deeper financial markets, probably reflecting that firms and households have a wider array of financing sources, and that market are more flexible. The effect of trade openness is, instead,

negative, suggesting that the effects of monetary shocks are enhanced by the exchange rate channel. The coefficient associated to the monetary shock is negative and significant: this coefficient – which corresponds to the constant in equation (2) – probably reflects that potential determinants have been omitted.

Thus, a second exercise tries to provide a more precise measure of the characteristics of financial markets. Following the methodology described by Beck et al (2000) in their database of financial development, we construct two quarterly series: the ratio of central bank assets to overall financial assets (to account for the relative importance of the central bank within the financial sector) and the ratio of banking assets to overall financial assets (to measure the relative importance of the banking sector vis a vis alternative sources of financing). However, the data required to construct these series on a quarterly is scarce. Thus, the sample of countries is restricted to 16 nations: Australia, Canada, Denmark, Germany, Israel, Italy, Japan, Korea, Netherlands, Norway, Peru, the Philippines, Portugal, Spain, Switzerland, and the United States.

Ex ante, the effect associated to the level of stock market capitalization is ambiguous: it could either be associated to smaller effects of monetary shocks (as it should diminish the importance of banking transmission associated to the credit channel), or with a higher impact on agents' wealth of monetary actions. The ratio of banking assets to stocks and bonds, on the other side, is included to capture the importance of the credit channel. Unfortunately, data problems leas to drop the variable on banking sector assets. Table 2 presents the results of the estimation of equation (3) for the new sample of countries. Again, inflation volatility has a positive, significant coefficient, while the shock is associated to a negative, significant effect. The relative size of central banking assets have a negayive coefficient, suggesting that monetary policy has more effects in countries where the central bank plays a more important role within the financial sector. However, the coefficient is statistically non-significant.

The results suggest that a more precise assessment of specific determinants is required, although the potential impact of monetary policy seems to be significantly related to macroeconomic stability. Thus, we now focus our attention in the case of Chile. First, by providing an assessment of the evolution of the effects of monetary shocks since the 1990s. Second, by using the methodology described herein to analyze the determinants of monetary transmission in the policy actions conducted by the Central Bank of Chile.

III.B Evidence for Chile

III.B.1 VAR analysis

VAR models have been a popular framework for the study of monetary policy in recent years, as they are able to embody the interaction between the conduct of monetary policy and the economy without ascribing to a particular theoretical model. Although the impulse- response functions derived from VARs are usually described as effects of non-systematic monetary shocks, they are only partially so. In fact, while the initial shock

correspond to an unsystematic change in the policy rate, the fact that the rate then behaves according to its equation ("policy rule") and –eventually- continues to impact the remaining variables, imply that the observed response in either output or inflation is a combination of non-systematic and systematic effects..

Mies, Morandé and Tapia (2002) survey the literature that, using VAR models, analyzes the output and inflation effects of monetary policy shocks in Chile. One conclusion that can be derived from this analysis is that, apparently, the output effects of interest rate shocks have changed in time. In particular, the implicit elasticities[26] found in recent studies, including data for all the 1990s (Bravo and García, 2001), are significantly smaller than the ones found in the studies including observations up to the mid-1990s (Valdés, 1997; García, 2001).

This fact seems to be reinforced when the authors estimate 6-year rolling windows VARs, calculating impulse-response functions for each window. The results confirm the previous evidence, showing that a significant decrease in the implicit elasticity of policy shocks as the decade advances. However, a more careful examination of the results shows that this decrease id far from being smooth or steady, but an abrupt decline once the year 1998 is included in the sample. In fact, while the elasticity falls sharply between the windows 1992-1997 and 1993-1998 (almost 10 times!), it remains relatively stable since then. What could explain this?

What explains this? While during all the decade the "official" policy rate was almost equal to the interbank interest rate (the very short-term rate over which the Central Bank has great influence, and which measures liquidity in the monetary market), during 1998 both rates were very dissimilar during some specific episodes. In fact, and in response to speculative attacks on the pesos in January, June and September, the Central bank aggressively constrained liquidity, although its policy stance remained unaltered or only increased – relatively – little. Indexed market rates skyrocketed to values as high as 25% average in September 1998 – more than 1200 basis points than the values observed the previous month. As these increases were only temporal – liquidity was restored to normality after a few days[27] - the variance of interest rates in a sample including 1998 is high – way above the one observed in any other period. Thus, policy "shocks" associated to 1998 are much larger than the ones calculated for windows excluding that year, while the calculated output or inflation effects do not change accordingly. Why was the reaction of output so "small"? Probably, due to the existence of non-linear effects that a linear specification does not capture. Arguably, the increase in policy rates observed in 1998 was so extreme as to become "irrelevant" above a certain threshold. The same effect would have been observed if rates had increased to 100% or 2000%: liquidity becomes in fact non-existent, and the interest rate becomes a price at which no one trades. In fact, measured elasticity would have been even smaller if rates had reached such a level.

[26] Calculated, for example, as the maximum (significant) output response relative to the initial policy shock, or as the accumulated (significant) output response over the accumulated (significant) change in the interest rate.

[27] In fact, the 25% average hides that, on specific days, annualized were as high as XX%, completely draining liquidity from the market.

Table 3 illustrates this issue. Three alternative monthly VARs are estimated between 1991:1 and 2002:12 : one with output levels, one with 12-month output growth, and one with the output gap (as deviation from the Hodrick-Prescott filter). The following variables are included (from most exogenous to most endogenous): 12-month CPI inflation, the inflation target, the indexed policy rate[28], the corresponding output measure, the real exchange rate (in level or in growth rate, depending on the output specification) and real money balances (same as with the RER). Exogenous variables include a constant, an index of foreign inflation, the Federal funds rate and the change in the terms of trade. A trend is included for the VAR in levels. A dummy for 1998 is included for windows including that year. The optimal lag, as suggested by the Schwartz criteria, is 1. Impacts are identified using the Choleski decomposition.

First, impulse responses are estimated for VARs including the whole sample (upper panel in Table 3). Significant effects are found when the output is measured in levels and in variation, but not when it is measured as a gap. The lower panel in Table 3 shows the evidence described earlier: the effects of elasticity change abruptly – roughly to one tenth - when the window includes 1998, and seem to remain roughly stable ever since, for any of the three specifications. Thus, two additional windows are estimated: one prior to 1998 (1991 to 1997) and one after 1998 (1999 to early 1993). Despite the fact that these windows have different length, and thus are probably not strictly comparable, they suggest how the inclusion of 1998 – and the incapacity of the VAR to account for the linear effects associated to it – could be distorting the previous results. Although monetary policy appears as non-significant after 1998 (probably due to the fact that the sample is too short), the elasticities implicit in the output response function, although smaller than the ones observed in the previous period, do not exhibit the sharp decrease observed in the previous windows. Elasticities fall between 33% and 66%, far away from the 90% decrease that could have been deduced from the windows that included the 1998 shocks.

Thus, a more careful look at the VAR evidence suggests that, although the output effects of monetary shocks have in fact decreased in time, the magnitude of the change is smaller than the one that could have been deduced from previous studies.

III.B.2 The determinants of monetary transmission

The VAR analysis presented in the previous sub-section suggested that, although monetary effectiveness seems to have changed in Chile in recent years such a result is significantly influenced by the severe policy shock in 1998. In fact, the greater difference in impulse response functions is found when comparing a time-window that includes the 1998 events with one that excludes them. Comparisons between windows that both exclude 1998 or both include 1998 are much more similar. This suggests that, to a certain extent, the effects of monetary policy are non-linear, and thus a linear approximation is reasonable for

[28] In 1998, this rate is replaced by the interbank rate to account for the "actual" rate ruling the monetary market. After july 201, when the Central Bank replaced its indexed policy rate with a nominal rate, the rate corresponds to the nominal rate minus inflation expectations for the relevant horizon.

"normal" policy shocks, but not for the huge shift in interest rates experienced the 1998 turmoil. However, finding that the effects of monetary policy have not experienced big shifts does not imply that changes have been non-existent, or that understanding what lies beyond them is irrelevant.

Regarding the first question, the VAR evidence suggested that the impact of monetary policy shocks (defined in the particular way a VAR operates which, as discussed earlier, combines both non-systematic and systematic effects) has decreased in time. The question, then, is seeing what could lie behind this phenomenon.

From a conceptual standpoint, one can think of several developments that, during the last decade, could have altered the transmission of monetary shocks. For example, the attainment of macroeconomic stability, which, as discussed earlier, should be associated to an increase in the effect of non-systematic monetary surprises. However, other developments, such as the increase in financial depth or the elimination of capital controls[29]. Moreover, the reaction function itself might have changed, reflecting the elimination of explicit or implicit targets (the exchange rate, the current account) that were in place until the economy achieved its "steady-state" level of inflation and began operating under a "full-fledged" inflation targeting regime. In a similar fashion, as transparency has grown in time – and as the agents have become more aware of the Central Bank's reaction function – the existence of monetary shocks may have decreased, as the agents correctly anticipate monetary responses to changes in output and inflation. What is identified as "less" effectiveness could simply reflect that we identify as "policy shocks" are no longer unanticipated monetary decisions; their small effect is due to the fact that they were largely expected by the market.

Thus, all these reasons suggest that it is feasible that, although the observed effects of monetary policy might have only changed marginally, its determinants might have evolved in time in different directions.

To analyze this, we use the same approach adopted when analyzing the international evidence. First, a Taylor-like reaction function is estimated, with inflation and the output gap as determinants. The residuals of that equation are interpreted as policy shocks. However, and as discussed, one problem with this type of exercise is that, if the policy reaction function in itself or transparency regarding objectives[30] monetary shocks associated to monetary decisions could be misidentified. As it seems that both factors have indeed changed in recent years (the Central Bank' reaction function evolved during the 1990[31], and the degree regarding its objectives and future decisions has grown significantly), it is likely that estimating a unique reaction function for the whole period is misleading. Thus, we directly used data on expectations on the policy rate, derived since 1998 from the forward interest rates curve (such data is not available before). A Taylor rule is estimated between the first quarter of 1991 to the last quarter of 1997, its residuals being

[29] Which restricted access to external funding, diminishing the "completeness" of financial markets.
[30] This, the market's knowledge of the central bank's reaction function.
[31] See, for example, Schmidt-Hebbel and Tapia (2002).

interpreted as policy shocks. Between 1998 and 2003, monetary shocks are the difference between actual policy rates and the expected values derived from the forward market. As the most significant changes in the central bank's reaction function (the 1998 turmoil, the adoption of steady state IT) and transparency in monetary management have occurred precisely since 1998, such a division – although forced by data availability – seems reasonable.

The Taylor rule is estimated using GMM, including a constant, the one-period interest rate lag, the contemporaneous output gap, and the inflation gap three quarters ahead as determinants (results and further discussion are presented in the appendix).

As before, a second, non-linear equation has the output gap as the dependent variable, with controls and non-linear elements to account for the determinants of monetary shocks. This model is not intended to fully explain the behavior of the output gap nor all factors behind the monetary transmission mechanisms, but to encompass different theories (and general wisdom) on transmission channels evaluating if there is any statistically significant relation change in time.

The effect measured by this equation is not strictly comparable to the one obtained in the VAR. While the impulse-response function obtained from the VAR reflects the impact of a monetary shock that is followed by systematic changes in the interest rate – defined on a monthly frequency -, this measure only considers the contemporaneous effect of a non-systematic monetary shock, defined on a quarterly basis. Thus, observing differences in magnitude and time evolution between both specifications should not be a surprise.

What variables are considered as potential determinants of the coefficient associated to the monetary shock? The use of Chilean data allows us to construct a richer set of explanatory variables, including macroeconomic, financial, and regulatory features. In particular, the included variables are as follows:

- Macroeconomic variables: inflation volatility; average inflation; trade openness; cyclic position (dummy that equals if GDP is above its trend); asymmetric effects of monetary policy (dummy for positive interest rate shocks);

- Financial variables: stock market capitalization ratio to GDP; relative size of the banking system relative to the stock- plus bond market size;

- Policy/regulatory variables: effective capital controls, as obtained from Gallego and Hernández (2003); nominal exchange rate band width.

The precise definition of each variable, and its source, is presented in the appendix.

The intuition behind some of these variables has been already discussed. Inflation volatility and inflation average are included as measures of macroeconomic stability, with

monetary policy potentially having higher real effects when the economy is more stable. The effect of trade openness is ambiguous: while it could be associated to higher effects of monetary shocks through the exchange rate channel, it could imply higher competition – implying more price flexibility and deeper markets. The two dummy variables are included to test if some asymmetric effects are observed in monetary policy shocks, either in the direction of the shock itself or in the economy's state (these asymmetries can be derived from the logic behind the credit channel. This could be consistent with growing evidence suggesting that the Philips curve could have a convex shape (Agénor, 2002), so that positive (negative) output gaps tend to be more (less) inflationary than negative ones.).

The effect associated to the level of stock market capitalization is ambiguous: it could either be associated to less effects of monetary shocks (as it should diminish the importance of banking transmission associated to the credit channel), or with a higher impact on agents' wealth of monetary actions. The ratio of banking assets to stocks and bonds, on the other side, is included to capture the importance of the credit channel.

Finally, two variables are included to account for changes in the policy and regulatory framework. A measure of effective capital controls, as constructed by Gallego and Hernández (2003), is included to account for a restriction on arbitrage between foreign and domestic interest rates[32]. Higher capital controls limit access to external funds, thus making firms more dependent on domestic credit. The width of the exchange rate (defined as an index between 0 and 1; the variable is 1 after the adoption of a float in 1999) is included to measure the extent of exchange rate flexibility, which we associate with the potential importance of the exchange rate channel.

The equation is estimated using OLS, using White heteroskedasticity-consistent standard errors & covariance. The regression runs from the first quarter of 1991 to the fourth quarter of 2002. Results are shown in Table 4. Most of the variables have the expected sign.

The impact of the monetary shocks by itself, which corresponds to the constant (α) in the equation explaining the coefficient β, is positive but non-significant. This does not mean that the effect of shock is positive (non-significant), but rather that the equation that explains does not have a significant constant.

As with the international evidence, inflation volatility is associated to a positive, (marginally) significant coefficient: the impact of monetary shocks decreases as inflation volatility rises. Thus, as inflation volatility has diminished in Chile with the attainment of macroeconomic stability, monetary policy shocks should have become associated to more significant effects on output[33]. However, the sign of the inflation level is rather

[32] In fact, Gallego and Hernández (2003) find that capital controls had a significant, asymmetric effect on private firms access to financial funding.

[33] Again, this effect is conditional on the fact that the cenral bank adequately manages monetary policy, and does not try to systematically exploit the Philips curve it implies.

counterintuitive[34], as it is negative and significant: monetary policy shocks had more effect when inflation was higher. It is feasible that this coefficient features another trend (as inflation smoothly decreases throughout the decade) that has diminished the impact of monetary policy[35]. Could this somehow reflect the fact that monetary policy has become increasingly transparent? That explanation could be convincing if, as discussed earlier, we would have used as "shocks" the residuals obtained from a Taylor rule estimated for the whole period. If that were the case, residuals identified as "shocks" could correspond to perfectly anticipated variations in the monetary stance, with small real effect. This could wrongly indicate that the potential for monetary effects has decreased in time. However, the fact that we have used market expectations for a significant share of our sample, thus having a more precise measurement of shocks, seems to discard that explanation.

The size of the stock market seems to increase the effect of a monetary shock: as discussed, this suggests that the effect associated to the assets channel is greater than the one associated to less dependence on bank financing, and a weakening of the credit channel. The variable directly intended to control for the credit channel (the relative importance vis a vis direct funding) has the expected, significant sign: monetary effects are bigger if alternative sources of funding are less important.

As expected, the size of capital controls capital controls are associated with stronger real effects of monetary shocks, as they reduce the space of arbitrage and external funding. This result is coherent with the evidence of Gallego and Hernández (2003), who found that capital controls were relevant for the firms funding opportunities. An increase in exchange rate flexibility also augments the effects of the monetary shock, suggesting that – as monetary policy becomes less bound by an exchange rate commitment, the exchange rate channel becomes more important. Finally, trade openness appears as reducing the extent of monetary effectiveness: we interpret this result as reflecting more competition leading to more flexible prices.

Finally, the dummies for cyclic position and the sign of the monetary shock appeared as non-significant, thus being dropped from the regression.

Thus, the results obtained from estimating the determinants of the impact of monetary shocks are interesting, and generally coherent with our conceptual priors. While the reduction of inflation volatility and the increase in exchange rate flexibility observed in the last decade should have implied an increase in the potential impact of monetary shocks, an increase in the relative size of non-banking sources of finance should have implied the opposite. What is the net effect over monetary transmission of the changes experienced in its determinants, reflected in an estimated coefficient for the effects of monetary shocks?

[34] In a Lucas-type aggregate supply model the level of inflation plays no role in the effects of monetary surprises, while in a neokeynesian framework higher inflation should be associated to smaller real effects of monetary shocks.

[35] Although a possible explanation would be that inflation and inflation volatility are collinear, results for each variable are robust to the exclusion of the other.

Figure 1 depicts the estimated coefficient associated to monetary transmission - this is, the net, combined effect of all its potential determinants. Coherent with the VAR evidence, the absolute value of the coefficient decreases throughout the decade, being 20% smaller at the end of the sample than what was observed at the mid-1990s. Although this trend is milder than the one suggested by the VAR, both methodologies are not strictly comparable in sample or in the measurement of the monetary effect. The coefficient also exhibits a cyclical behavior, suggesting that the effects of monetary policy, even if constant in average, can change at different points in time.

IV. Conclusions

This article has focused on the output effects of monetary policy, and the determinants of monetary transmission. The paper first stresses a simple idea – almost too simple -, but that seems to be usually forgotten in the policy debate: the output effect of monetary policy – the short-run non-neutrality of money – is mainly due to the presence of some type of market imperfection. Correctly conducted, monetary policy can play a useful, beneficial role in providing nominal stability, as well as smoothing output fluctuations, allowing the economy to attain a higher level of warfare. However, monetary policy only comes as a "second best", as the economy would be better off if market imperfections or incompleteness – even if such if such an outcome makes monetary incapable of affecting output.

Empirically, the paper – basing itself in concepts derived from the theoretical transmission channels of monetary policy – has analyzed the determinants of the impact of unanticipated, non-systematic shocks on output. International evidence, gathered from panel estimations, suggested that macroeconomic stability and financial depth played a significant role i the size of the response of output to monetary shock.

For the case of Chile, the paper confirms previous evidence using VAR models – the real effects of monetary have decreased in time -, but suggests that the decrease is smaller than the one suggested by previous literature, as the radical policy fluctuations experienced in 1998 distort the results.

Regarding the determinants of monetary transmission in Chile, the results are consistent with the theoretical priors: factors as the relative size of the banking sector in the financial system, or the level of capital controls, increase the impact of a given monetary shock. The evolution of the simulated coefficient associated to policy shocks, tracked through the behavior of its determinants, shows, as indicated by the VAR evidence, that it has decreased – albeit marginally – during the decade.

Table 1

Dependent Variable: Output gap Estimation method: Generalized Least Squares (Variance Components) with Random Effects Sample: 1990:1 2002:2 Included observations: 52 Number of cross-sections used: 25 Total panel (unbalanced) observations: 954	
Variable	**Coefficient**
Constant	--7.3E-5 (0.0001)
Monetary shock	-4.5E-5 (1.54E-5)
(Monetary shock)*(Inflation volatility)	1.59E-6 (5.52E-7)
(Monetary shock)*(Financial depth)	5.8E-5 (3.0E-5)
(Monetary shock)*(Openness)	-1.95E-9 (1.96E-8)
Output gap(-1)	0.767 (0.021)
GLS Transformed Regression	
R-squared	0.57
Adjusted R-squared	0.57
S.E. of regression	0.01
Durbin-Watson stat	1.96
Unweighted Statistics including Random Effects	
R-squared	0.52
Adjusted R-squared	0.52
S.E. of regression	0.01
Durbin-Watson stat	1.76

Table 2

Dependent Variable: Output gap Estimation method: Generalized Least Squares (Variance Components) with Random Effects Sample: 1990:1 2002:2 Included observations: 50 Number of cross-sections used: 16 Total panel (unbalanced) observations: 647	
Variable	**Coefficient**
Constant	-0.0002 (0.0002)
Monetary shock	-0.0004 (0.0003)
(Monetary shock)*(Inflation volatility)	3.02E-05 (1.53E-05)
(Monetary shock)*(Ratio of central bank assets)	-0.002 (0.003)
World output gap	0.068 (0.024)
Output gap(-1)	0.761 (0.025)
GLS Transformed Regression	
R-squared	0.61
Adjusted R-squared	0.61
S.E. of regression	0.01
Durbin-Watson stat	1.85
Unweighted Statistics including Random Effects	
R-squared	0.53
Adjusted R-squared	0.53
S.E. of regression	0.01
Durbin-Watson stat	1.55

Table 3

		Output in level		12-month output variation		Output and inflation gap	
		Inflation	Output	Inflation	Output	Inflation	Output
1991-2003	Average/ Max	NS (-0.04)	-0.002/-0.011	NS (-0.03)	-0.39/-0.17	NS (-0.03)	NS (-0.06)
	Significant periods	_	4 to 6		4 to 7	_	_
Before 1998	Average/ Max	-0.38 /-0.83	-0.004/-0.012	-0.67/-0.88	-1.85/-2.58	NS (-0.41)	-1.15/-1.28
	Significant periods	2 to 3	2 to 3	2 to 3	2 to 3	_	2 to 7
After 1998	Average/ Max	NS (-0.32)	NS (-0.008)	NS (-0.38)	NS (-0.74)	NS (-0.33)	NS (-0.55)
	Significant periods						

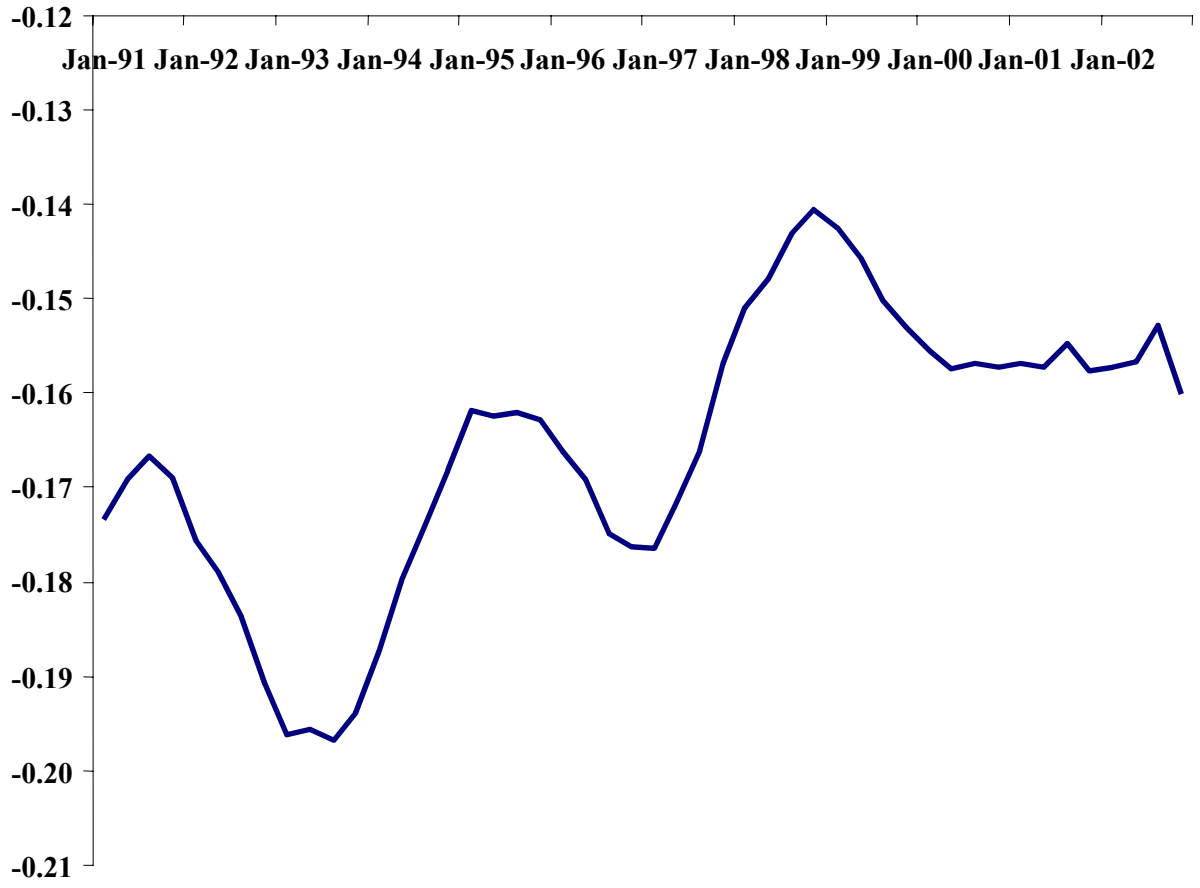
		Output in level		12-month output variation		Output and inflation gap	
		Inflation	Output	Inflation	Output	Inflation	Output
1991-1996	Average/ Max	NS (-0.89)	NS (-0.01)	-0.37/-0.97	-3.21/-3.43	NS (-0.61)	-1.41/-0.95
	Significant periods			2 to 3	4 to 11		2 to 6
1993-1998	Average/ Max	NS (-0.03)	-0.003/-0.001	NS (-0.05)	-0.43/-0.30	NS (-0.05)	-0.28/-0.11
	Significant periods		3 to 4		2 to 3		3 to 5
1995-2000	Average/ Max	-0.05/-0.05	-0.003/-0.001	NS (-0.04)	-0.38/-0.22	-0.05/-0.05	-0.22/-0.12
	Significant periods	2	3 to 4		2 to 3	2	3 to 4
1997-2002	Average/ Max	-0.12/-0.04	-0.004/-0.001	-0.18/-0.045	-0.51/-0.20	-0.28/-0.045	-0.46/-0.11
	Significant periods	2 to 4		2 to 8	3 to 5	2 to 8	3 to 7

Table 4

Dependent Variable: Output gap / Sample: 1991:1 2002:4 Least Squares; Included obs.: 48			
Variable		Coefficient	
Constant		0.00 (1.57)	
Output gap (-1)		0.75 (9.18)	
Monetary shock		0.16 (0.88)	
Inflation volatility* Monetary shock		0.41 (1.76)	
Size of Stock market* Monetary shock		-0.06 (-2.21)	
Relative importance of banking sector* Monetary shock		-0.25 (-3.18)	
ER Band width* Monetary shock		-0.06 (-1.71)	
Effective reserve requirements* Monetary shock		-0.01 (-2.53)	
Trade Openness* Monetary shock		0.66 (2.52)	
Inflation* Monetary shock		0.00 (-2.84)	
R-squared	0.83	Mean dep. var	0.00
Adj. R-squared	0.79	S.D. dep. var	0.02
S.E. of reg.	0.01	Akaike info crit.	-6.52
Sum squared resid	0.00	Schwarz crit.	-6.13
Log likelihood	166.44	F-statistic	20.11
DW stat	1.88	Prob(F-statistic)	0.00

Figure 1

Evolution of the Estimated Effect of a Monetary Shock on the Output Gap



Source: Authors' calculations.

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Sample

Group 1	*Group 2*
Australia	Australia
Canada	Canada
Czech Republic	Denmark
Denmark	Germany
Ecuador	Israel

Germany	Italy
Hungary	Japan

Variable	*Description*	*Source*
Err	Effective capital controls: defined as the unremunerated reserve requirements adjusted for changes in the coverage of the capital base on which the reserve is required, and the effectiveness or power of the tax	Gallego, et al (2001)
*y, y**	Domestic and external output gap: defined as the difference between the real GDP and its HP-filtered value	Authors´ calculations, Central Bank of Chile, IMF
BW	Band width defined as the width of the band of the exchange rate normalized as bw/(1+ bw)	Authors` calculations, Central Bank of Chile, IMF
inf_vol	Inflation volatility measured as the 18 month-rolling standard deviation of inflation;	Authors` calculations, Central Bank of Chile
Openess	Trade openness measured as exports plus imports to GDP	Authors` calculations, Central Bank of Chile
cycle	Dummy variable taking the value 1 when the output gap is positive and 0 otherwise, and finally	Authors` calculations, Central Bank of Chile