Heterogenous responses to monetary policy regimes: A regional analysis for Turkey, 2009–2019

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The heterogeneous response of regions to interest rate shocks is a severe issue that reduces the effectiveness of monetary policy. While the impact of interest rate shocks is central on policymaking, less has been discussed about the spatial heterogeneity in influencing macroeconomic policy implementations. In order to fill this gap, the authors explore regional responses to monetary policy in developing countries, such as Turkey. The main aim of the paper is to investigate how different regions adjust the extent of real economic activity in response to an exogenous country-wide shock in the interest rate policy. The analyses cover 81 Turkish provinces using monthly data from January 2009 to November 2019. To consider temporal and spatial patterns in the same framework, time-series analyses via unit root, co-integration, and VAR with spatial methods have been combined, including exploratory spatial data analysis and spatial econometric models. Preliminary findings validate that regional economic activity measured by employment responses is heterogeneous across provinces and policy regimes. Among the different determinants in assessing responsiveness to monetary policy shocks, interest rate, broad credit channels, and certain regional demographics have explanatory power. Moreover, sizeable spatial spillovers have been detected, which are believed to be crucial in evaluating the externalities and the exact impact of the country-wide policy shock in Turkey. Combined results indicate that the macroeconomic policy impact and spatial externalities are visible only during monetary expansion periods.

Keywords:
monetary policy,
regional heterogeneous responses,
employment,
VAR

Online first publication date: 28 June 2022

Introduction

Monetary policy is commonly designed at the national scale, where price and macro-financial stability are the most important targets (Fischer 1996, Anagnostou–Papadamou 2012). While financial and money markets are the direct impact areas of monetary policy, the real part of the economy is inevitably influenced by policy implementations. Considering the mutual feedback between certain monetary tools and real economic activity (e.g. interest rate, exchange rate, etc.), monetary policy has significant potential to create an impact on output and employment growth (Mishkin 1996, Soskice–Iversen 2000, Ülke–Berument 2016, Petrakos et al. 2021, Berument et al. 2009, Cambazoglu–Karaalp 2012).

A second vital dimension of monetary policy is investigating its impact at the national level. In a way, this could be perceived as natural, as the financial and monetary markets are mostly centralised, unlike fiscal decentralisation practices. However, although direct reflections of monetary policy can be regarded as national, its local impact is also heterogeneous and remarkable (Ridhwan et al. 2014, Carlino–DeFina 1998, 1999, Owyang–Wall 2009). This becomes even more central when examining the effect on real economic activity, showing sizable local variation, especially in developing countries.

Motivated by these two points (i. indirect effect of monetary policy on real economic activity, i.e. production and employment; ii. potential local differences in the impact of the policy), this study examines how monetary policy shocks are reflected at the regional level in Turkey – a developing country with persistent spatial heterogeneities (Filiztekin 1998, Gezici–Hewings 2007, Kirdar–Saracoğlu 2008, Yildirim–Öcal 2006, Yildirim et al. 2009). Specifically, we analyse the diversity of the impact of monetary policy on 81 Turkish provinces, which we discuss as significantly variable across provinces and different policy regimes.

While doing this, we aim at understanding how regional economic activity, which we measure by employment levels, responds to expansionary and tightening monetary stance. Further, this study aims to analyse the extent of spatial networks that define the borders of the local impact of monetary policy shocks. Finally, we aim at investigating the reasons behind regional differences in employment responses through several different specifications. While our central focus is on money market channels (interest rate, exchange rate, and credit channels), we also incorporate other socio-economic/demographic and spatial variables (Goodness–Rangan 2012, Owyang–Wall 2009, Carlino–DeFina 1999, 1998, Hayo–Uhlenbrock 2000, Ridhwan et al. 2014, Mishkin 1996, Taylor 1995, Kashyap–Stein 2000, Oliner–Rudebusch 1996, Bernanke–Gertler 1995, Gertler–Gilchrist 1993). Specifically, we address the following research questions inadequately addressed in existing studies.

a. *Do regions respond heterogeneously to the monetary policy shocks?* b. *Do the regional responses vary across the policy regimes?* c. *What are the underlying economic/demographic/spatial determinants of these responses?*

We believe that our findings will contribute to the literature on different pillars. First, examining the impact of monetary policy at the local level provides sizeable information on how the daily lives of localities are affected by macroeconomic policymaking. This will enable policymakers to question additional fiscal and social measures to mitigate the pervasive adverse effects of monetary policy disturbances on local economic activities. In our setup, we go a step beyond and incorporate the spatial dimension. The spatial analysis use has not been central to monetary policy, which contains additional information on how monetary policy influences local economic activity. Spatial spillovers, which define spatial externalities, will help to explore the local impact of monetary policy (Furceri et al. 2019). This impact area can be potentially different from the one defined by the administrative boundaries. Among the many studies detailed in the References section, this has been discussed for the United States (Giacinto 2003, Korobilis–Gilmartin 2010). Similarly, Rodriguez-Fuentes–Dow (2003) examined the European Monetary Union by emphasising the importance of observing the regional dimension of monetary policy implementation. Recently, Sokol–Pataccini (2021) highlighted the underlying mechanics of the regional monetary policy dimension during the COVID-19 outbreak. Moreover, spatial clustering, which depicts spatial heterogeneity, guides the definition of different local spatial regimes through which monetary policy will have an asymmetric influence on society. Prior studies show that these dimensions have not been central before (Furceri et al. 2019, Duran–Erdem 2014). We argue and acknowledge that monetary policy does not aim at targeting economic activity or employment growth. Furthermore, we highlight the legal position of the Central Bank of the Turkish Republic (CBRT) in dealing with price stability. However, simultaneously, it cannot cancel out or ignore the influence of monetary and financial development on the real part of the economy (Bank of International Settlements 2009). Therefore, we believe our empirical approach will provide new insights into how the impact of monetary policy can be examined by considering its direct and indirect influence on the local economic activity.

Generally, Turkey's monetary transmission mechanisms and boom-bust cycles are likely to occur in the following ways (Onaran–Oyvat 2016, Akyüz–Boratav 2003): depending on the expectations, capital inflows or outflows increase, which appreciates or depreciates the domestic currency. For instance, a depreciated currency increases the inflationary pressures as the prices of imported goods rise, representing an important cost item for firms. Consequently, producer and consumer prices tend to increase. Following this, a tightening monetary policy is often applied to bring back capital inflows by raising policy interest rates. Hence, economic growth is dampened due to higher interest rates. Conversely, expansionary monetary regimes are applied

to stimulate growth during periods in which inflation and exchange rate depreciation is low and stable. Notably, both regimes have other potential influences of different macroeconomic fundamentals.

In a way, we must remember that CBRT, in principle, takes action by prioritising price stability and inflationary pressures. If not supported by fiscal and social policies, these policies can generate asymmetry, especially during economic and financial instability periods. Potential political and economic conflicts that are a result and reason for monetary policymaking are a separate discussion that we will not detail in this study.

A second important contribution is the hybrid empirical approach, which combines time-series and spatial analyses. In our spatial analyses, local responses to monetary shocks are captured through the historical examination of employment and interest rate figures. We computed local responses to interest rate shocks through a careful time-series analysis. This approach enables us to endogenously examine how Turkish regions adjust to sudden changes in interest rate (and regime) (Ridhwan et al. 2014, Carlino–DeFina 1998, 1999, Owyang–Wall 2009). To the best of our knowledge, such an indirect examination has the potential to express long-lasting debates on the effects of monetary policy, especially at the local level.

The final contribution relates to methodological innovation. Unlike the traditional approach, our approach distinguishes between local impacts during two different policy regimes (contractionary and expansionary monetary policy periods). In theory, the two regimes are expected to exhibit different results because monetary tightening and expansion are applied under different circumstances. However, the existing studies do not adequately consider this in empirical analyses (Furceri et al. 2019).

The study has the following sections. We document a brief literature summary of existing studies in the second section. Subsequently, we estimate the provincial responses to monetary policy and their differentiated responses during contractionary and expansionary policy periods. We also explore its spatial variation and patterns by applying exploratory spatial data analysis (ESDA). Further, we analyse the underlying sources of cross-regional heterogeneity in responses. Finally, the study concludes by providing a summary and a policy discussion.[1]

Literature review

In the scholarly literature on the regional effects of monetary policy clusters, several streams have emerged over recent decades.

First, one stream explores dissimilarities in regional sensitivity to monetary policy shocks. This is a less addressed but severe problem. The core idea is that a centrally

[1] The empirical analyses are implemented using the following software: Eviews 4, Eviews 10, R (The R Project for Statistical Computing), Stata, Geoda (Bivand et al. 2019, Pfaff–Stigler 2018).

decided interest rate will be non-optimal for some regions, as they do not have perfectly synchronous business cycles (Duran 2013, 2015, Ferreira-Lopes–Sequeira 2012, Weyerstrass et al. 2011, Montoya–De Haan 2008, Frankel–Rose 1998, Fatás 1997, Mundell 1961). For instance, while a region in a low-growth phase will benefit from a lower interest rate, another region that experiences a high-growth phase will require a higher interest rate. This problem is recognised widely as an asymmetric monetary transmission and is extensively studied for Eurozone countries and its eligibility for an Optimum Currency Area (OCA) (Duran 2013, 2015, Ferreira-Lopes–Sequeira 2012, Weyerstrass et al. 2011, Montoya–De Haan 2008, Frankel–Rose 1998, Fatás 1997, Mundell 1961). In the OCA, monetary policy functions better and can achieve macro-stabilisation more quickly in terms of price and output growth smoothing.

To maintain an OCA, it is necessary to have the following: high interregional labour mobility, free flow of workers with different skills, flexible wage and price systems together with highly mobile capital, intense trade and financial integration, similarity in responses to shocks, and a fiscal redistribution system that provides a risk-sharing mechanism to mitigate regional heterogeneities (Duran 2013, 2015, Ferreira-Lopes–Sequeira 2012, Weyerstrass et al. 2011, Montoya–De Haan 2008, Frankel–Rose 1998, Fatás 1997, Mundell 1961, Broz 2005, Kunroo 2015).

However, it is much less emphasised in emerging economies and far less studied at the regional scale (Guo–Masron 2014, 2017). Emerging economies possibly include more regional economic heterogeneity than the Eurozone, amplifying this policy problem. Other valuable studies on developing countries focus on inflation, monetary policy, growth, and exchange rate issues at the regional or national scale. Examples include studies of Kuncoro (2020a, 2020b, 2021), Gonzalez (2020), Purwono et al. (2021), Ramdhan (2021), Kocziszky et al. (2018), and Jona (2015). Nevertheless, there is a need for more updated studies on the influence of monetary policy actions on regional economies and their differential responses.

Another pitfall of the literature is that existing studies have mostly analysed periods as a whole (see Crone [2007] for a study on US regions, Arnold–Vrugt [2002] for Netherlands, and Anagnostou–Papadomou [2012] for Greece). We argue that it is useful to split the period into monetary tightening and expansion periods (Furceri et al. 2019). These two periods may have considerably different impacts on regional economies, as unanticipated changes in interest rates may exhibit diverse effects on regions, depending on their economic and demographic structure. Hence, allowing this time-wise heterogeneity may provide more relevant phase- or region-specific policy implications.

Second, the study has focused on why some regions are more affected than others by monetary policy actions. This has been extensively debated in existing studies. Regional responses to monetary policy may vary significantly depending on industrial structure, establishment size, degree of exposure to foreign economic circumstances,

and other structural characteristics of regions (Goodness–Rangan 2012, Owyang–Wall 2009, Carlino–DeFina 1999, 1998, Hayo–Uhlenbrock 2000, Ridhwan et al. 2014, Mishkin 1996, Taylor 1995).

Three main channels are put forward in the study: (i) interest rate channel, (ii) credit channel (broad and narrow credit channels), and (iii) exchange rate channel. The interest rate channel claims that provinces that include more industries are going to be more vulnerable to interest rate shocks (such as durable manufacturing goods, semi-products, etc.) and are likely to suffer more from monetary contraction (Goodness–Rangan 2012, Owyang–Wall 2009, Carlino–DeFina 1999, 1998, Hayo–Uhlenbrock 2000, Ridhwan et al. 2014, Mishkin 1996, Taylor 1995, Kashyap–Stein 2000, Oliner–Rudebusch 1996, Bernanke–Gertler 1995, Gertler–Gilchrist 1993). Broad and narrow credit channels predict that regions with larger firms and banks are less worse affected by monetary tightening, as they can quickly reach additional or external financial resources with lower transaction and information costs compared to small firms and banks (Goodness–Rangan 2012, Owyang–Wall 2009, Carlino–DeFina 1999, 1998, Hayo–Uhlenbrock 2000, Ridhwan et al. 2014, Mishkin 1996, Taylor 1995, Kashyap–Stein 2000, Oliner–Rudebusch 1996, Bernanke–Gertler 1995, Gertler–Gilchrist 1993, Duran–Erdem 2014). Finally, the exchange rate channel claims that export-oriented provinces suffer more from contractionary monetary disturbances (Hayo–Uhlenbrock 2000, Kumar–Dash 2020). An increase in the interest rate may trigger capital inflows, leading to domestic currency appreciation, which increases the prices of exported goods. These regions lose their competitiveness in foreign markets as the goods to be exported become more expensive (Hayo–Uhlenbrock 2000, Kumar–Dash 2020).

Although theoretical literature and empirical studies have focused excessively on the three hypotheses, many demographic and economic variables are mostly neglected (Goodness–Rangan 2012, Owyang–Wall 2009, Carlino–DeFina 1999, 1998, Hayo–Uhlenbrock 2000, Ridhwan et al. 2014, Mishkin 1996, Taylor 1995, Kashyap–Stein 2000, Oliner–Rudebusch 1996, Bernanke–Gertler 1995, Gertler–Gilchrist 1993, Guo–Masron 2014, 2017, Georgopoulos 2009). Therefore, we adopt a broader perspective and incorporate other demographic (such as the young and active population) and innovation- or flexibility-type variables.

Finally, notably, although there is extensive literature on developed economies (See Owyang–Wall [2009], Di Giacinto [2003], Carlino–DeFina [1999] for regions in the United States; Rodriquez-Fuentes–Dow [2003] for EU regions), the issue has not been adequately investigated in emerging economies such as Turkey. Some other examples of these studies from developing cases are as follows: Ridhwan et al. (2014), Ridhwan (2013), and Ridhwan–Bary (2018) for Indonesian regions; Blanco et al. (2019) for Argentinian regions; Duran–Erdem (2014) for Turkish provinces; Anagnostou–Gajewski (2019) for Polish regions; Olamide–Maredza (2019) for the Economic Community of West African States (ECOWAS) zone. They found sizeably

differential output and employment growth responses of regions to monetary policy shocks. In the context of Turkey, the only study pursued by Duran–Erdem (2014) analysed provincial output responses to interest rate during 1975–2000 and found diverse responses. This study departs from that study by examining a more recent period (2009–2019) and adopting monthly employment data rather than annual gross domestic product (GDP) data. Moreover, we analyse many more determinants (economic, demographic, etc.) compared to Duran–Erdem's (2014) study. The results of these studies are also considerably different.

In summary, there is a need for updated empirical studies on this topic, which we focus on in the following section, adopting the innovative perspectives explained previously.

Empirical approach

Our empirical setup has a two-stage structure. In the initial stage, we aim to analyse the time-series properties of our data and understand the extent of local employment responses to monetary shocks. Next, we use the pre-constructed regional responses (in the initial stage) and investigate the spatial dimension by implementing exploratory spatial data analyses and spatial econometric methods.

Heterogeneous responses of Turkish provinces

The method we use for estimating the employment responses is the reduced-form VAR analysis (as used by Ridhwan et al. [2014], Duran–Erdem [2014], Owyang–Wall [2009], and Carlino–DeFina [1999, 1998]):

$$y_t = \partial + \sum_{k=1}^{k} B_k \, y_{t-k} + u_t \tag{1}$$

y is the vector of endogenous variables, ∂ is the intercept term, B_k is the matrix of estimated coefficients, k is the lag length, and u_t is the random residual term, assumed to be independent, identically, and normally distributed. (Stock–Watson 2001, Sims 1980). The endogenous variables employed in the VAR analysis are as follows:

$$y_t = \{\Delta exch_t, \Delta cpi_t, \Delta ppi_t, \Delta int_t, \Delta emp_{n,t}, \Delta emp_{i,t}\} \tag{2}$$

The details of the variables are presented in Table 1. Five variables are used in the VAR analysis. Four of these are aggregate (national) variables. The variables are the consumer price index *(cpi),* producer price index *(ppi),* central bank policy interest rate *(int)* (overnight rate), and exchange rate *(exch)* (Turkish Lira [TL] against USD). The last variable is the employment variable *(emp*), which has two forms: the national one $emp_{n,t}$ and that for provinces $emp_{i,t}$. The subscript *n d*enotes national variables, and *i* denotes the provinces; *t* represents the period (months). The lag length in VAR

estimations is decided based on the Schwartz criterion, where a maximum of 12 months is allowed (Schwartz 1978).

These variables include mostly similar variables used in Taylor rule-type policy descriptions that directly estimate the reaction of policy interest rate to inflation, output gap, or exchange rate, and the relative weight given to these variables by monetary policy (Taylor 1993, Gerlach–Schnabel 2000). However, our target in this model is somewhat different: we intend to understand the influence of monetary shocks on local employment levels and related heterogeneity. Therefore, we use similar variables with the Taylor rule (such as *cpi, ppi, int, and exch*) but estimate the direct effect of monetary action innovations on local employment trajectories.

In our study, the employment variable represents economic activity. Many studies in this field have adopted regional GDP data (or personal income) (e.g. Owyang–Wall 2009, Carlino–DeFina 1998, 1999), whereas few studies have used employment or unemployment (Blanco et al. 2019, Anagnostou–Gajewski 2019, Georgopoulos 2009). Employment data have several advantages over GDP. First, unemployment is an unsolved socioeconomic issue in developing countries. It is even more important in the Turkish case, as Turkey has one of the highest unemployment rates among European countries. Second, provincial GDP is available at the annual frequency in the Turkish case, whereas provincial employment can be obtained monthly. Third, we use provincial employment data rather than NUTS (Nomenclature of territorial units for statistics) 2 level employment figures. In the Turkish case, NUTS 2 level employment data are provided by Turkish Statistical Institute (TurkStat) and produced from the sampling of the Labour Force Survey. However, we use the Turkish Social Security Institute (SGK) registration data, which examine registered employment at a more local level (NUTS 3 provinces).

Before proceeding with VAR analysis, it is useful to check the time-series features of the variables. We start by using an augmented Dickey-Fuller (ADF) test for the variables representative at the national level (Dickey–Fuller 1979, Said–Dickey 1984, MacKinnon 1991, 1994, 1996). The test results and details are presented in Table 2. Consequently, all variables follow the (1) process, which implies that the variables at levels do not exhibit a stationary evolution but become stationary at first differences.

Hence, these non-stationary variables may exhibit co-integrating relationships in the long run. To check for the existence of co-integration, we apply Johansen's co-integration test (for details on the test, see Johansen 1988, 1991).

A summary of the test results under the different assumptions is presented in Table 3. Our results show no robust co-integrating relationships between the variables because these statistics are not persistently statistically significant. Hence, it becomes technically feasible to continue with the VAR analysis using the first differences of the variables.

Table 1

Definition of variables, monthly data (January 2009 to November 2019 in Turkey)

Variables	Definition	Scale	Unit	Data source
emp	Number of actively working people	National: emp_n Provincial: emp_i	Number of people (in natural logarithm and seasonally adjusted)	Social Security Institute, Republic of Turkey [2])
cpi	Consumer price index	National	Index number, basis 2003=100 (in natural logarithm and seasonally adjusted)	Turkish Statistical Institute [3], Central Bank of Republic of Turkey [4]
ppi	Producer price index	National	Index number (in natural logarithm and seasonally adjusted)	Turkish Statistical Institute [3], Central Bank of Republic of Turkey [4]
int	Interest rate (overnight rate)	National	Percentage (in natural logarithm) Average of lending and borrowing rate	Central Bank of Republic of Turkey [4]
exch	Exchange rate (USD against Turkey)	National	Turkish Liras against USD (in natural logarithm)	[5]

Table 2

Unit root analyses, ADF test results in Turkey

Variables	Levels	Lag length	First differences	Lag length
emp	–1,100322	0	–12,2163***	0
corecpi	2,29678	2	–8,119388***	0
ppi	1,050506	2	–6,771934***	1
int	–1,933	1	–8,53705***	0
exch	0,498476	1	–8,758498***	0

Note: ADF Critical Values for 1%: –3,48, for: 5%: –2,88, for 10%: –2,57 (MacKinnon [1991, 1994, 1996]). Max.lag=12 months; Schwarz's (1978) criterion (SC) was used.

Table 3

Johansen co-integration test analyses in Turkey

Data trend	None	None	Linear	Linear	Quadratic
Test type	No intercept No trend	Intercept No trend	Intercept No trend	Intercept Trend	Intercept Trend
Trace	3	2	0	1	1
Max-eig	1	1	0	0	0

Notes: The number of cointegrating equations was determined using the critical values provided by MacKinnon et al. (1999) (p-value <0.05 accepted). VAR lag length is applied using SC, max. lag=12 months.

After assessing the time-series features of the variables at the national level, we also examine the stationarity of the provincial employment variable (Δemp_i). Table A1 in Internet Appendix presents the results of the corresponding ADF tests. All the provinces follow a significant stationary employment growth pattern.

We start by estimating Equations 1 and 2 following the VAR approach offered by Pfaff–Stigler (2018), Stock–Watson (2001), and Sims (1980). All variables are in natural logarithms and first difference. Having estimated the VAR system for the national economy and provinces, we directly focus on the cumulative employment's impulse-response functions (IRF) to unanticipated shock to the interest rate. We estimate the VAR system for all provinces and present the cumulative 24-months responses in Table A2 (see Internet Appendix). Orthogonal responses are used in the IRF estimations.

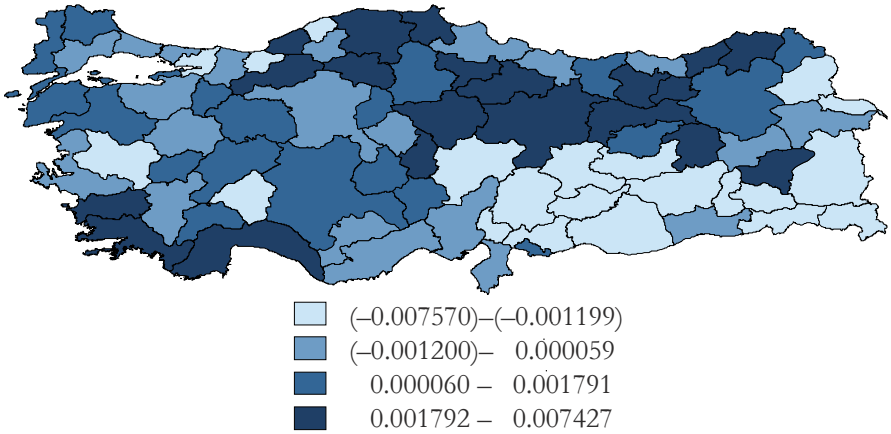
Generally, our results indicate variability in the IRF at the provincial level. We observe diverse responses for the 81 provinces, as IRF ranges between 0.0074 (Çankırı Province) and -0.0075 (Şırnak Province). Whereas 39 provinces exhibit a negative response, 42 provinces show a positive response. This indicates the clustering of regions within two different groups.

We argue that these initial results point to challenges in understanding the outcomes of monetary policy implementation. Moreover, these results are also candidate motivations for questioning the spatially varying impact of centrally determined interest rates. Naturally, these preliminary results highlight that the decision to divert the direction of the monetary policy (from tight to lose or otherwise) calls for a holistic knowledge of the local differences in social, demographic, and inevitably economic fundamentals of regions, in case policymakers care about the inclusiveness of the policy reflections. Observing diverse responses to interest rate shocks underlines the degree of challenges in adapting to monetary policy implementations at the regional scale.

The spatial distribution of the cumulative IRFs is shown in Figure 1. It appears that industrial zones (around Istanbul, Izmir, and Iskenderun ports), the less developed places in Southeastern Anatolia, seem to react positively (negatively) to interest rate decreases (increases). Conversely, southwestern tourism regions (Muğla-Antalya) and middle or northern Anatolian rural or agricultural regions exhibit positive (negative) reactions (to employment) as the interest rate increases (decreases). The remaining regions have response values close to zero. These results show that the economic activity response measured by the employment rate is regionally non-homogenous. Remarkably, the historically industrialised regions and the southeastern regions' increase (decrease) in interest rates seem to have adverse (beneficial) effects on local economic activity. At this stage, we have to highlight that these responses are short-term responses of local economies and do not consider the long run.

Figure 1

Cumulative IRF of Turkish provinces at 24th quarter



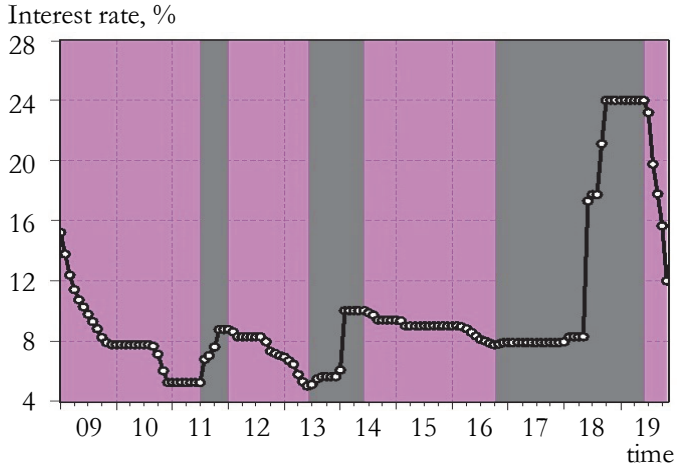
Regional responses during monetary expansion or contraction regimes

Our preliminary analysis examines the period as a whole. However, monetary policy may follow the expansionary and contractionary phases. Naturally, such periods have diverse effects at the regional level.

The pink shaded periods in Figure 2 are when the expansionary monetary stance is applied, whereas the grey coloured periods are the monetary tightening periods. In emerging economies, interest rates tend to follow pro-cyclical (in an asynchronous way with the national business cycle) and counter-cyclical paths depending on the sources and type of interest rate shock.

Figure 2

Evolution of interest rates in Turkey



Source: [4].

The political circumstances of these periods is notable. Historically, the Turkish economy has suffered structural issues such as high unemployment, inflation and current account deficits, low savings, and high foreign debt (Orhangazi 2019, Rodrik 2012). These structural issues are endogenously related to the implementation of economic policy. The balance between fiscal and monetary policy has always been a topic of discussion among scholars working on Turkey's political economy. In our setup, while we acknowledge the importance of the fiscal side, our main focus is on the monetary policy dimension. Therefore, monetary policy developments deserve separate attention.

The central objective of CBRT is to stabilise the general price evolution.[2] To do so, it has been targeting inflation and applying a floating or flexible exchange rate system since 2002; inflation targeting has been applied implicitly between 2002 and 2006 and explicitly since 2006.[3] Regarding the policy mix, the highest weight is given to inflation, and a limited weight is assigned to the output gap (Aklan–Nargeleçekenler 2008).

Historically, from January 2009 to July 2011, the interest rate has been gradually decreased from approximately 16% to 5%. This was done to stimulate economic growth against the recession experienced during the global financial crisis of 2008/09. Depending on the national or international economic circumstances, consecutive periods of monetary contraction and expansion were observed. However, these changes were moderate until 2018. During the tightening period – August 2011 to January 2012 – the interest rate increased from approximately 5% to 9%. Afterwards, during the period from February 2012 to June 2013, was again lowered from approximately 9% to 5%. From July 2013 to June 2014, the interest rate has increased from approximately 5% to 10%, whereas in the next expansion period – July 2014 to October 2016 – it has been lowered from 10% to 8%.

During the period from November 2016 to June 2019, the policy movements were considerably more pronounced. In 2018, fundamental macroeconomic problems in Turkey (such as a high current account deficit) were coupled with rising external political tensions. As a result of capital flights, the TL depreciated remarkably against major foreign currencies (Boratav 2019). Hence, cost-push inflationary pressures have increased rapidly. Following this, the interest rate increased from approximately 8% (in 2016) to 24% (in 2018). However, after resolving the related problems, it decreased to approximately 12% (in 2019). Finally, most recently, it has been reduced to 9.75%

[2] Source: [4]: https://www.tcmb.gov.tr/wps/wcm/connect/d6ac47f4-379f-43da-bf2b-7ad855dca0ff/ING+KANUN-Temmuz+2019.pdf?MOD=AJPERES&CACHEID=ROOTWORKSPACE-d6ac47f4-379f-43da-bf2b-7ad855dca0ff-mMqfpBB

[3] Source: [4]: https://www.tcmb.gov.tr/wps/wcm/connect/EN/TCMB+EN/Main+Menu/Core+Functions/Monetary+Policy/Central+Bank+Monetary+Policy+Framework

(in 2020) to stimulate the economy against the worldwide downturn driven by the COVID-19 pandemic.[4]

To examine the possibility that regional responses to monetary policy decisions are not identical during expansionary and tightening periods, we estimate the VAR system in Equations (1) and (2) separately for the two different periods. We interact with each endogenous variable in the VAR model with two dummies:

d_exp: 1 if it is a monetary expansion phase; 0 otherwise (expansion phases: January 2009 to July 2011; February 2012 to June 2013; July 2014 to October 2016; July 2019 to November 2019).

d_tight: 1 if it is a monetary contraction phase; 0 otherwise (contraction phases: August 2011 to January 2012; July 2013 to June 2014; November 2016 to June 2019).

d_exp (d_tight) represents the monetary expansion (tightening) periods in which the interest rate tends to decrease (increase).

At the provincial scale, we run the VAR for specific periods and report or demonstrate the cumulative 24 months IRF values in Table A3 (see Internet Appendix) and their spatial distribution in Figure 3. Our findings demonstrate that regions have diverse regional responses during different phases of monetary policy.

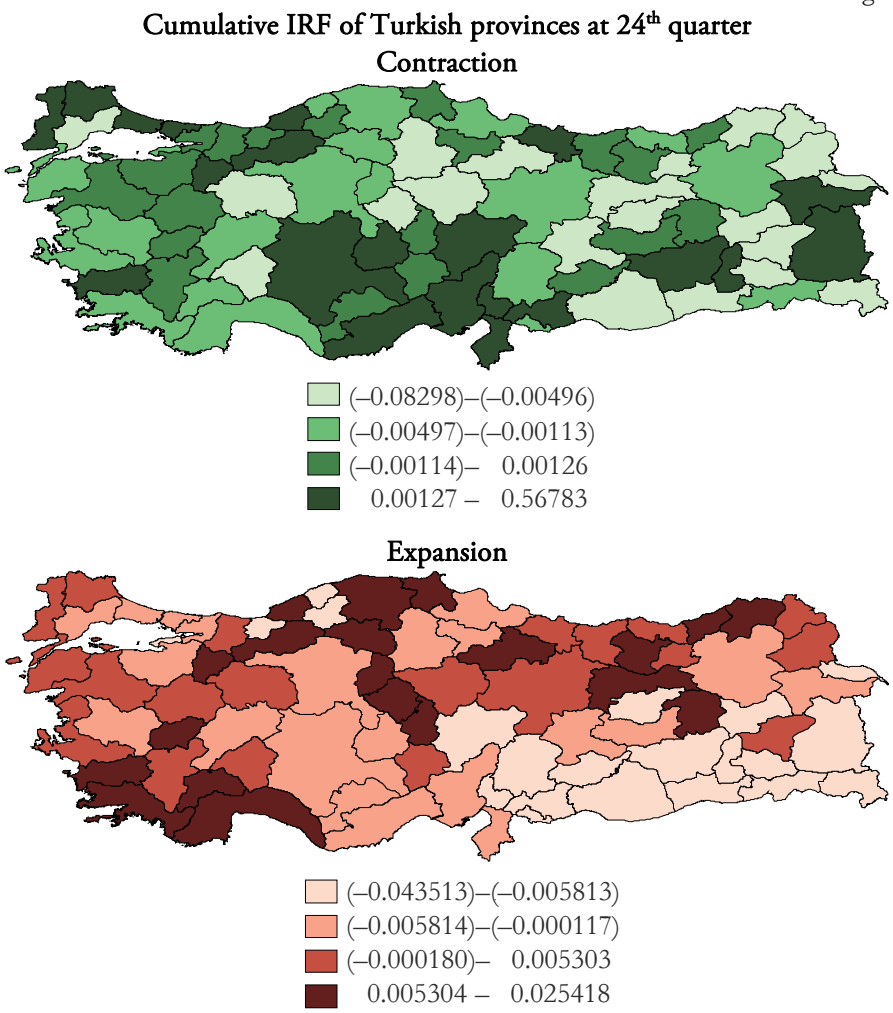
The responses are considerably pronounced during tightening periods and range between 0.56 (Van) and –0.08 (Ardahan). We do not observe a certain regional clustering, and the regions' responses during tightening periods are spatially homogenous.

This homogeneity might result from the following: during the monetary tightening periods, which generally occurred during negative shock times, a rise in the interest rate had almost equal effects on regional employment patterns. The rise in interest causes an increase in credit, financing, and investment opportunity costs. The increase in related costs and reduced demand for goods push firms to cut their investments and production levels. Accordingly, employment decreases more homogenously in local economies. This homogeneity is most likely to occur because of panic or herding behaviour observed almost simultaneously and at all places throughout the country. It appears that the responses are randomly distributed in space. While 49 provinces show a negative response, the remaining 32 provinces show a positive employment growth response to the interest rate increase.

However, this pattern changes once we analyse the IRFs for the monetary expansion periods. The responses of the provinces are relatively more heterogeneous. The responses range between –0.044 (Şirnak) and 0.025 (Çankiri).

[4] In this study, the impact of monetary policy during sub-periods and two external shocks (such as COVID-19) were not analysed since the time was limited. Instead, the diverse local impacts of different policy regimes were focused on.

Figure 3



Our preliminary findings show that monetary policy has a dissimilar spatial pattern in contractionary and expansionary periods. Unlike the spatial distribution of IRF for the tightening periods, our results for the spatial distribution of IRF during more expansionary periods show sizeable spatial clustering of the regions. This reminds us of the possibility of spatially non-random distribution. In other words, stimulating economic growth via monetary policy is a challenging task, as, unlike expectations, many provinces do not respond conveniently when an expansionary policy is selected.

Initial findings on the geography of regional employment responses to monetary policy validate that regions in close spatial proximity may exhibit similar responses based on policy direction. We conducted a major ESDA to assess the spatial spillovers and

locality of regional responses to monetary policy. We argue that these spatial exercises will enable us to understand the spatial features of the relationship and yield a more inclusive policy insight to evaluate how regions can smooth out monetary policy shocks. To understand the spatiality of the regional impact of monetary shocks, we perform a set of spatial analyses using the estimated IRF responses of provinces for the whole period (Table A2) and different phases (Table A3 in Internet Appendix).

We first check for spatial autocorrelation using Moran's I and Geary's C statistics (Moran 1950, Geary 1954, Anselin 1995, 2019, Rey–Montouri 1999, Fitriani et al. 2021). This first step enables us to understand the possible spatial spillovers and dependence of IRFs at the provincial level. We argue that responses or provinces can be well beyond territorial administrative boundaries.

Moran's I and Geary's C are two important indicators of spatiality and are commonly used in the applied study (Moran 1950, Rey–Montouri 1999, Ozyurt–Dees 2018, Geary 1954, Sielska–Pawłowska 2016, Anselin 1995, 2019, Karahasan–Bilgel 2019, Rey 2001). These statistical tests examine the existence of spatial associations against the null hypothesis of non-spatiality. Notably, Moran's I has a domain between [-1,1], where positive values point to positive spatial association (Moran 1950, Rey–Montouri 1999, Karahasan–Bilgel 2019, Karahasan 2020, Karahasan–Pinar 2021, Ma et al. 2013). The zero value refers to spatial randomness. For Geary's C values above (below) 1 point to positive (negative) spatial correlation (Geary 1954, Sielska– Pawłowska 2016, Karahasan–Bilgel 2019, Karahasan–Pinar 2021), the value of 1 indicates spatial randomness. The technical details and formulations of these indicators can be found in the studies of Moran (1950) and Geary (1954).

Our analyses use the inverse distance and binary contiguity weight matrices. In the former type, the cells of the matrix are denoted by $1/d_{i,j}$, where $d_{i,j}$ is the distance measured in kilometres between provinces *i* and *j*.[5] In this matrix, the closer provinces are given more weight to each other than provinces farther away. In the latter, the cells take a value of 1 if two provinces are neighbours with a common border and 0 for those that do not have a common border. Distance data were obtained from the General Directorate of Highways [1].

Table 4

Spatial autocorrelation measures in Turkey, Moran and Geary's C test

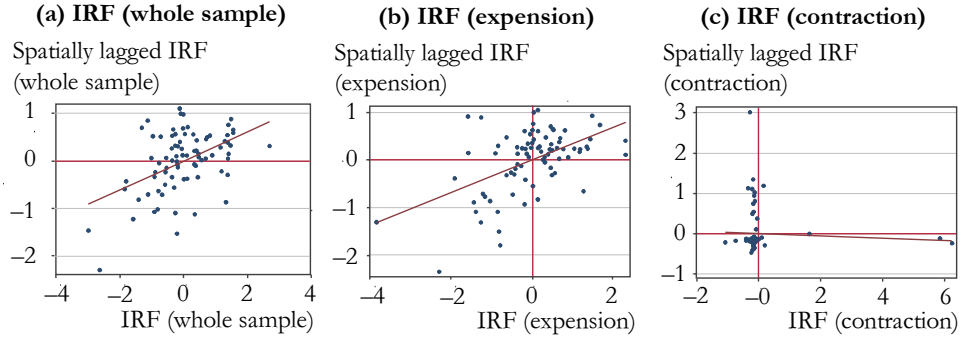
	Moran's I		Geary's C	
	Contiguity	Inverse distance	Contiguity	Inverse distance
IRF (all sample)	0.306***	0.041***	0.686***	0.935***
	(0.071)	(0.016)	(0.078)	(0.019)
IRF (expansion)	0.342***	0.077***	0.616***	0.892***
	(0.071)	(0.016)	(0.081)	(0.020)
IRF (contraction)	–0.028	–0.017	1.067	0.977
	(0.055)	(0.013)	(0.130)	(0.039)

[5] Data source for the distance between provinces: General Directorate of Highways [1].

Table 4 presents the results; our results are twofold. While we detect positively significant spatial autocorrelation for the whole sample and the monetary expansion periods, we detect a spatially random pattern for the IRFs calculated for monetary contraction episodes. Our results are robust to the selected spatial autocorrelation measures (Moran's I and Geary's C) and different types of weight matrices (inverse distance and contiguity). These results indicate that the spatial dependence that we observe for the entire sample period mostly originates from the extent of spatial externalities in the labour markets, which mostly operate during the implementation of expansionary monetary policies. An implementation of expansionary monetary policy corresponds to the spillover of employment growth from one province to the neighbouring provinces, possibly through various input-output linkages, trade and financial investment relationships, commuting patterns, and migration (Armstrong–Taylor 2000, LeSage 2008). However, this spatial spillover mechanism is ineffective during monetary contraction periods, as Moran's I and Geary's C are statistically insignificant. Moreover, although observing spatial auto-correlation enables us to understand the possibility of policy diffusion, it does not explain the winners and losers. Additionally, these responses are short-term immediate local reactions. They do not explain the long-run evolution of labour market conditions affected mainly by a combination of monetary, fiscal, and labour market-based policy implementations.

Figure 4

Moran scatter-plots for Turkish provinces



Note: Moran's I=0.3060 and P−value=0.0010.

Note: Moran's I=0.3415 and P−value=0.0010.

Note: Moran's I=0.2275 and P−value=0.5570.

The second important spatial dimension is the spatial heterogeneity and locality of spatial externalities. As a preliminary check, we first decompose the Moran scatter plot, which gives an overall assessment of the distribution of spatial dependence (Moran 1950, Rey–Montouri 1999, Ozyurt–Dees 2018, Geary 1954, Sielska–Pawłowska 2016, Anselin 1995, 2019, Karahasan–Bilgel 2019, Rey 2001). Figure 4 provides evidence of spatial association and confirms the initial findings of positive spatial dependence. Our findings indicate a strong relationship between provinces

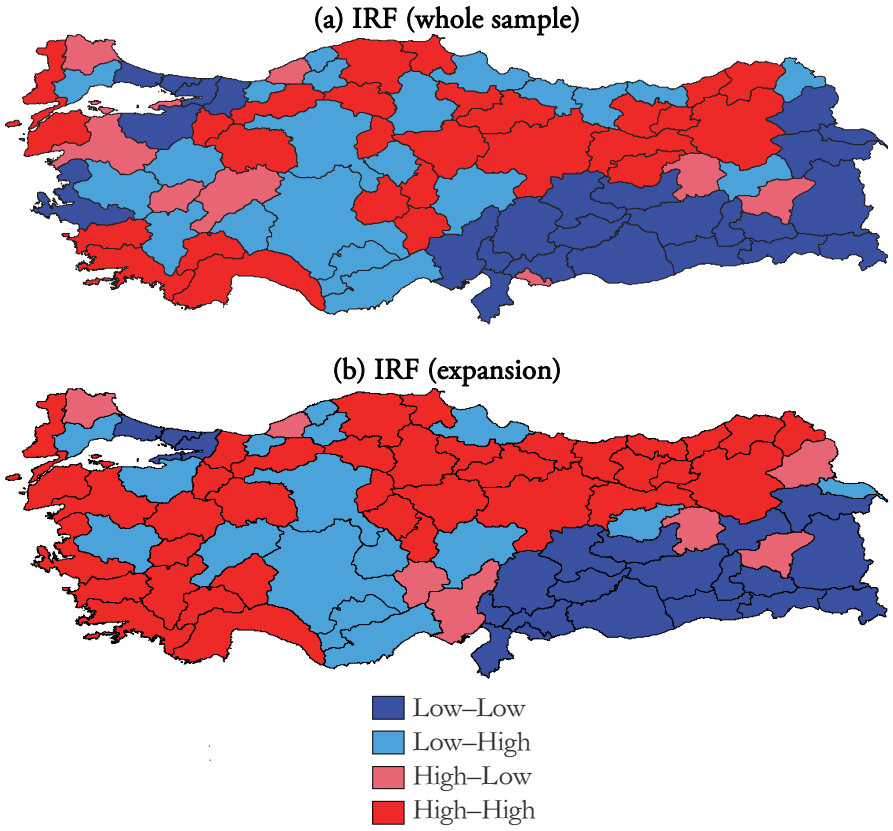
nearby for the whole sample and expansionary monetary policy period. In other words, provincial responses to monetary policy shocks appear spatially correlated during monetary expansion periods and the whole period. However, this spatiality is statistically insignificant during monetary contraction periods.

Another useful analysis is applied using a local Moran I. Following Anselin (1995, 2019) and Rey (2001), we compute the local Moran I using the following formula (Equation 3):

$$I_i = \left(x_i - \bar{x}\right)\sum_j w_{ij}\left(x_j - \bar{x}\right) \tag{3}$$

Figure 5

LISA analyses for Turkish provinces



The local indicators of spatial association (LISA) maps are shown in Figure 5. As the Moran scatter plot and global spatial autocorrelation indicate no spatial autocorrelation during the monetary contraction periods, we do not illustrate the LISA for the IRF of the monetary contraction period. Meanwhile, for the whole

sample period and the monetary expansion periods, the localities of the spatial networks are considerably similar. Similar to our earlier findings, this suggests that the local spatial association of provincial responses to monetary policy shocks mostly occurs during the expansionary period. Notably, in our LISA analyses, we disregard the local significance to focus on the direction of the local spatial networks.[6] Regarding the grouping of the spatial regimes, red coloured regions represent 'high-high' spatial clusters. When interest rates are lowered, these areas exhibit lower employment growth. Conversely, the blue regions represent 'low-low' zones. When the interest rate is lowered, these regions exhibit higher employment growth. In terms of geographical pattern, regarding the whole period, places around Istanbul and the northeastern provinces exhibit a low-low pattern. Conversely, the southwestern provinces and Mideast-Northern provinces form a high-high cluster. A similar pattern is observed for monetary expansion periods. These findings confirm that a nationwide policy shock to monetary policy has geographically dissimilar impacts. Apparently, there are still losers of expansionary monetary policy choices at the local level.

Based on these mechanisms, our findings provide interesting insights into the local reflections of monetary policy implementation. Notably, local spatial networks are almost identical for the entire sample period and the monetary expansion period, confirming our previous analyses. For instance, low-low regions are generally concentrated around the Istanbul port's hinterland, a manufacturing belt with high specialisation in industrial production. This geography also dominates trade- and service-based economic activities. Note that these sectors are known to be interest-rate-sensitive and credit-dependent. Moreover, southeastern provinces, known as agriculture and trade based areas, are also characterised by low-low regimes. Hence, when the interest rate is lowered during expansionary policy times, these regions will increase the employment rate and can fulfil the potential of employment growth and take advantage of monetary expansion.

Meanwhile, we observe two major high-high regions. The first one is around south and western Aegean coastal provinces including Izmir, Muğla Antalya, Çanakkale. The second one is around the North (Blacksea) and Middle/Northern provinces including Kastamonu, Amasya, Tranbzon, Rize, Sivas and Erzurum as major cities. The first zone represents a tourism belt, whereas the second represents a rural, agriculture, or horticulture belt. These two zones cannot take the advantage of monetary expansion. When the interest rate decreases during expansionary policy regimes, the abovementioned places respond by decreasing their employment growth.

Overall, our spatial analyses indicate spatial asymmetries in provincial responses to monetary policy, which makes this study more interesting. However, a careful

[6] Rey (2001) emphasized that analyses of LISA can be problematic due to local significance (Karahasan 2020, Karahasan–Bilgel 2019, Karahasan–Pinar 2021).

inspection reveals that spatial networks and the extent of spatial heterogeneity are influenced by monetary policy regimes. We observe effective spatiality for global and local analyses of the entire sample. Nevertheless, spatial mechanisms are active mostly during expansionary monetary policy implementations, during which the less developed isolated territory of the country is mainly affected.

We argue that these heterogeneities and observed patterns may be due to the provinces' different economic, sectoral, and demographic structures. We aim to analyse this in the following subsection.

Determinants of the cross-provincial asymmetric response

Our first set of spatial analyses shows remarkable variation in regional employment responses. An inevitable follow-up concern is to investigate the background sources of the differences in responses to monetary policy. As highlighted in the introduction section, we focus on three major channels: **the interest rate channel**, **broad and narrow credit channels,** and the **exchange rate channel.**

The interest rate channel claims that the industrial structure of regions determines their responsiveness to policy shocks (Ridhwan et al. 2014, Carlino–Defina 1998, 1999, Mishkin 1996, Taylor 1995). Regions that specialise in cyclically sensitive, credit-dependent industries, such as manufacturing and construction, are likely to be more sensitive and more affected by monetary disturbances (Ridhwan et al. 2014, Carlino–DeFina 1998, 1999, Mishkin 1996, Taylor 1995). Second, **the credit channel** states that big firms cope better with monetary tightening because they have easier access to external funding (Bernanke–Gertler 1995, Oliner–Rudebusch 1996, Gertler–Gilchrist 1993). However, small firms rely largely on local bank loans, increasing their exposure to monetary shocks. Hence, regions with larger firms are less affected by monetary contraction (Bernanke–Gertler 1995, Gertler–Gilchrist 1993, Oliner–Rudebusch 1996). This is called the broad credit channel. Similarly, small banks are bound to local financial markets in a narrow credit channel because they have fewer alternative resources (Duran–Erdem 2014, Kashyap–Stein 2000). Moreover, these banks incur higher transaction and information costs. Thus, regions with smaller banks are expected to be hit more by monetary shocks in terms of growth and economic activity (Kashyap–Stein 2000). **The exchange rate channel** works through a completely different mechanism linked to country-based macroeconomic conditions. For instance, an increase in interest rates may accelerate capital inflows, which, in turn, creates domestic currency appreciation (Hayo–Uhlenbrock 2000, Kumar–Dash 2020). This process eventually increases export goods prices, thus lowering the competitiveness of the regional economy. Hence, export-oriented regions are likely to suffer more from monetary contraction policies (Hayo–Uhlenbrock 2000). Conversely, import-oriented regions are adversely affected. When the interest rate increases and the exchange rate appreciates, the prices of imported

goods decrease, enabling the cheap procurement of imported capital goods and raw materials. This, in turn, might have a growth-enhancing impact on the local economy. Another mechanism of the exchange rate channel argues that export-oriented regions build networks and reputations in foreign markets (Ber et al. 2001). Therefore, they can easily access external financing during monetary contraction periods, and therefore, their economic activity is less affected by a tight monetary stance (Ber et al. 2001).

Empirically, there exist various studies supporting one of these hypotheses. For instance, Georgopoulos (2009) analyses Canadian regions and highlights the existence of interest rate channels, as manufacturing and primary industries are more sensitive to monetary shocks. Conversely, Guo–Masron (2017) analyse Chinese provinces and find bank lending (a narrow credit channel) relevant. Finally, Anagnostou–Gajewski (2019) find that both the industrial mix and certain demographic variables of regions are important for understanding regional responses to monetary policy shocks.

Building on previous knowledge on how monetary policy can have spatially varying impacts, we investigate the regional differences in responsiveness to monetary policy by testing these central pillars and certain regional determinants for the Turkish economy. While doing this as a central contribution, we consider two important dimensions: (i) spatiality of regional responses and (ii) policy sensitivity of proposed channels. Our preliminary analyses confirm that spatial autocorrelation persists in response to monetary policy shock. Therefore, it is essential to consider spatial externalities within the empirical model. As Anselin (2010) discussed, neglecting the spatial mechanisms within regional models potentially biases the results from nonspatial specifications. However, an additional dimension of spatial mechanisms is the sensitivity of spatial autocorrelation to monetary policy direction. This makes period-based estimations mandatory. We estimate separate models for the whole sample and the expansionary and contractionary periods based on these concerns. To the best of our knowledge, these two dimensions have not yet been tested using the same setup.

Four separate setups were constructed. Our benchmark model is ordinary least squares (OLS), where we disregard the impact of spatial networks (Equation 4). Next, we construct three separate spatial models (Equations 5–7): the spatial autoregressive model (SAR), spatial error model (SEM), and spatial Durbin model (SDM) (Elhorst 2010, 2014, LeSage–Pace 2009, LeSage 2008, Anselin 1988, Anselin et al. 2008, Durbin 1960, Rey–Montouri 1999). As Kelejian–Prucha (1999) and Elhorst (2010) highlighted, spatial models can be simplified based on the significance of spatial mechanisms. Notably, each spatial econometric setup has a different spatial mechanism. The SAR model (Equation 5) assumes that spatial networks work over the dependent variable – regional responses to monetary shocks have a spatial spillover effect on proximity (Furceri et al. 2019). Meanwhile, SEM (Equation 6) predicts the spatiality of the omitted factors – responses to monetary policy shocks

can be influenced by outside factors common to spatial proximity (Elhorst 2010). This can be best captured by spatial heterogeneities and clustering, which explain the common characteristics of provinces that cause similar responses to exogenous shocks (for structural reasons behind the regional clustering of economic activity in Turkey, see Karahasan et al. [2016]). Finally, the SDM (Equation 7) assumes that the dependent and independent variables are spatially correlated. As we already highlighted, Furceri et al. (2019) emphasised spatial spillovers by considering the responses to monetary policy shocks. While this pattern can also be linked with structural differences among regions, as Mur–Angulo (2006) and Liu et al. (2016) argued, a complementary dimension within the SDM model assumes that factors that influence regional reactions to monetary policy can also be spatially correlated. Our setup considers several regional structural factors that are likely to be correlated across Turkish regions. We form our reasoning based on discussions conducted mainly for the Turkish economy (Doğruel–Doğruel 2003, Karahasan 2015, 2020) and the European Union (Ezcurra et al. 2007 among many others). We adopt a contiguity weight matrix (*W*) (Karahasan 2020, Karahasan–Bilgel 2019, Karahasan–Pinar 2021).[7] Note that estimating spatial variants of the benchmark model have two main motivations. First, the estimation of spatially dependent variables via OLS might result in spatially autocorrelated residuals, which might bias the initial set of results (Anselin 1988, Elhorst 2010). Second, spatial models enable the exploration of spatial mechanisms essential for understanding the extent of local networks (Elhorst 2010, 2014, LeSage–Pace 2009, LeSage 2008, Anselin 1988, Anselin et al. 2008, Durbin 1960, Rey–Montouri 1999).

$$OLS: \qquad IRF_i = \alpha + \beta X_i + \gamma Z_i + \theta T_i + \varepsilon \tag{4}$$

$$SAR: \qquad IRF_i = \alpha + \rho W IRF_i + \beta X_i + \gamma Z_i + \theta T_i + \varepsilon \tag{5}$$

$$SEM: \qquad IRF_i = \alpha + \rho W IRF_i + \beta X_i + \gamma Z_i + \theta T_i + \lambda W u + \epsilon \tag{6}$$

$$SDM: \qquad IRF_i = \alpha + \rho W IRF_i + \beta X_i + \gamma Z_i + \theta T_i + \xi W X_i + \varpi W Z_i + \kappa W T_i + \varepsilon \tag{7}$$

The dependent variable is the previously estimated provincial 24-months cumulative IRF. X comprises the central pillars to test interest rate, credit, and exchange rate hypotheses. The interest rate hypothesis includes two variables – industry share and services in provincial GDP – according to which states or regions that include intensive interest rate sensitive sectors (i.e, manufacturing, real estate services, etc.) tend to overact to monetary policy shocks (Ridhwan et al. 2014, Carlino–DeFina 1999, 1998, Mishkin 1996, Taylor 1995). The credit channel set includes provincial firm and bank size variables, measured by the number of employees per firm and bank. It is stated that larger firms and banks have greater

[7] We also estimate the regressions using an inverse distance type raw standardised spatial weight matrix (Karahasan 2020, Karahasan–Bilgel 2019, Karahasan–Pinar 2021). The findings virtually remain similar or the same and are available upon request.

advantages in accessing alternative financial resources during tight monetary regimes (Kashyap–Stein 2000, Oliner–Rudebusch 1996, Bernanke–Gertler 1995, Gertler–Gilchrist 1993). They may have lower transaction and information costs. Therefore, regions with larger firms and banks may be less negatively affected by a monetary contraction, as small firms and banks remain bound to bank loans (Kashyap–Stein 2000, Oliner–Rudebusch 1996, Bernanke–Gertler 1995, Gertler–Gilchrist 1993, Duran–Erdem 2014). The exchange rate channel is also tested using two variables: trade openness (share exports and imports in provincial *GDP*) and export performance (provincial [export-imports]/GDP). The rationale behind this class of variables is that highly open regions are likely to be influenced more by monetary tightening. This is because a rise in the interest rate is likely to appreciate the domestic currency while decreasing export volume (Hayo–Uhlenbrock 2000, Kumar–Dash 2020). Here, we must acknowledge that the economy's structure in terms of input reliance in the import market can adversely affect the country level. Naturally, reflections are likely to be observed locally. Regions can also benefit from currency appreciation due to the lower input costs of important investment goods and raw materials.

In addition to the traditional studies, existing studies have analysed demographic and innovation or entrepreneurship variables to a limited extent (Anagnostou–Gajewski 2019). To fill this gap, we also control certain demographic properties of regions (*Z*) using the provincial *young population rate* (share of 15–24 age group in provincial population*)*, *human capital* (percentage of individuals holding a university degree), and *active population* (share of 15–64 age group in provincial population) (Leahy–Thapar 2019). Additionally, we control the regional flexibility using the provincial capacity of *innovation* (measured by patents or population) and *entrepreneurship* (measured by newly founded firms or population). The regression analysis covers 81 provinces (NUTS 3 regions), and the data are collected for the most recent year in which the data are commonly available (2018). The details of all variables are explained in Table 5.

Table 5

Description of variables employed in regression analysis in Turkey

Abbreviation	Type	Definition	Measurement unit	Source
IRF	DEPENDENT VARIABLE	12 months cumulative impulse response function of provincial employment to interest rate	Percentage points	Own estimation
INDUSTRY	INTEREST RATE CHANNEL	Share of industry in total provincial GDP	Ratio	Turkish Statistical Institute [3]
SERVICE	INTEREST RATE CHANNEL	Share of services total provincial GDP		Turkish Statistical Institute [3]
FIRSIZE	CREDIT CHANNEL	Number of firms/number of employees	Number of workers per firm	The Union of Chambers and Commodity Exchanges of Turkey [6] Social Security Institute [2]
BANKSIZE	CREDIT CHANNEL	Number of banks/ number of bank employees	Number of workers per bank	The Banks Association of Turkey [7]
TRADE-OPENESS	EXCHANGE RATE CHANNEL	(Exports+Imports)/GDP	Ratio	Turkish Statistical Institute [3]
EXPORT-PERFORMANCE	EXCHANGE RATE CHANNEL	(Exports-Imports)/GDP	Ratio	Turkish Statistical Institute [3]
ACTIVE-POPULATION-RATE	DEMOGRAPHIC	15–64 years old population/total population	Ratio	Turkish Statistical Institute [3]
HUMAN-CAPITAL	DEMOGRAPHIC	Number of people graduated from a university program/population	Ratio	Turkish Statistical Institute [3]
YOUNG-POPULATION-RATE	DEMOGRAPHIC	15–24 years old population/total population	Ratio	Turkish Statistical Institute [3]
INNOVATION	FLEXIBILITY	Number of patent applications/population	Number of patent applications per capita	Turkish Statistical Institute, Turkish Patent and Trademark Institute [8]
ENTRE-PRENEURSHIP	FLEXIBILITY	Number of newly founded firms/population	Ratio	Turkish Statistical Institute [3], The Union of Chambers and Commodity Exchanges of Turkey [6]

The empirical results for the whole sample and the expansion and contraction periods are provided in Tables A4, A5, and A6 (see Internet Appendix), respectively. We begin by estimating OLS models with and without regional controls. We estimate the most augmented models for the spatial models, where we incorporate variables controlling regional demographics and flexibility. Starting with the analyses covering the entire sample for the augmented models with full controls, the share of industry and services has a negative and significant coefficient. Second, firm and bank size variables have significant and positive coefficients. Third, the share of the active population has a positive coefficient, whereas that of the young population has a negative coefficient. Fourth, innoviveness has a negative and significant coefficient. Hence, at a glance, the interest rate and credit channel seem to hold, where demographic variables and flexibility of regional economies also have a significant impact. Interestingly, the significance of spatial components is sensitive to model selection. Generally, SAR and SEM models are relatively more informative than models that only control the three channels. However, for most augmented models, including regional demographics and flexibility, spatial mechanisms are insignificant. This could be because certain regional characteristics of provinces capture the previously detected spatial externalities.

After assessing the factors assumed to have explanatory power to influence regional responsiveness to monetary policy shocks, we move a step further and investigate how these relationships hold during different phases of the monetary policy. Table A5 in Internet Appendix summarises the estimation results for the expansionary monetary policy period. Interestingly, the results are comparably similar with respect to the findings from the whole sample. The significant impact of the share of industrial GDP and firm size suggests that interest rates and credit channels are effective during the expansionary monetary policy period. For regional demographics, while the active population is positively associated with regional responses, the share of the young population is negatively related to regional responsiveness to monetary policy shocks. Finally, in line with the results for the entire sample, we detect a negative and significant impact on the innovation capacity of regions. Note that our findings for the spatial mechanisms are identical to our results for the entire sample. Finally, Table A6 in Internet Appendix reports the results of the contractionary monetary policy phases. Remarkably, none of the proposed channels is observed to be significant. We only report limited influence (10% significance) of service sector GDP in augmented models. Note that we do not report any spatial externalities, suggesting spatial randomness of the proposed channels. These results are consistent with the descriptive analyses described in the previous section. It seems that contextual relationships over interest rates and credit channels and the spatial externalities that we observe for the whole sample period mostly originate from the expansionary phases of monetary policy implementations.

An important challenge is interpreting these results, as they would embed information on understanding the locality of the links, which is valuable for constructing the right policy mix. Finally, our remarks will cover the results from Tables A4 and A5 in Internet Appendix, where we evaluate the mechanisms for the whole sample period and the expansionary periods together. First, the negative impact of industrial GDP means that provinces with a higher industry share are likely to respond in opposite terms to movements in interest rates. For instance, when interest rates decrease during a monetary expansion, these regions exhibit higher employment growth rates. This finding supports the interest rate channel. The rationale behind this may be that when interest rates are lowered, interest-rate-sensitive industries benefit more and create more employment. These sectors are possibly manufacturing, construction, trade, and services, which are cyclically sensitive and credit-dependent (Ridhwan et al. 2014, Carlino–DeFina 1998, 1999, Mishkin 1996, Taylor 1995). Second, concerning credit channel, firm size has a positively significant parameter that supports the broad credit channel's validity. When interest rates are lowered, provinces with smaller firms respond more positively and generate more employment during expansionary monetary regimes. It seems plausible that smaller firms typically rely on bank loans and credit. Hence, the decrease in the interest rate during loose monetary regimes provide an opportunity for 'low cost' credits and growth to these firms (Kashyap–Stein 2000, Oliner–Rudebusch 1996, Bernanke–Gertler 1995, Gertler–Gilchrist 1993).

Third, demographic variables, which are less analysed in the study, provide useful insights. For instance, the active and young population rates have positive and negative coefficients, respectively. Hence, one may argue that when the interest rate decreases, cities with younger populations realise higher employment growth. It seems plausible that cities with younger populations are likely to have higher productivity, faster adoption of new technologies, higher aggregate demand, and higher labour supply, stimulating employment growth during expansionary monetary regimes. Conversely, the positive coefficient of the active population rate is rather surprising.

Fourth, the flexibility of the regions also provides useful evidence. Cities' innovativeness has a negative and significant coefficient. Therefore, the innovative capacity of cities and the adoption of new technologies and processes are important because these regions are likely to experience higher employment growth during times of monetary expansion policy. This seems plausible, as these regions will have higher productivity growth, and the need for labour and employment growth will be higher. Thus, R&D activities, patents, trademarks, and specialisation in creative industries may be referred to as critically important policies for cities.

However, the implications of the findings for monetary tightening periods are considerably different. Evidence for the validity of the channels is mostly insignificant. The only significant variables are industry shares and services. These

variables have positive and significant coefficients but are sensitive to model selection. Nevertheless, a positive link postulates that when interest rates increase, provinces with higher specialisation in the industry and services sectors respond more positively to interest rate shocks and grow more in terms of employment during monetary contraction times. This finding is at odds with the well-known interest rate hypothesis. Nonetheless, given the non-robustness of these results, we approached these findings with caution.

Further, notably, the exchange rate channel is not valid, regardless of the phase analysed. This finding is crucial because it rules out that a devaluated local currency generates room for an export competitiveness advantage at the regional level. While we do not discuss the background details of the proposed channels, as highlighted before, this finding can be linked to the input reliance on imported goods in the Turkish economy. Overall, we also note that the spatial interaction variable is generally positive and significant during the expansionary policy regime but insignificant during monetary tightening periods. Thus, when an expansionary monetary shock hits a provincial economy, the impulses are spilled over neighbouring regions through various linkages and commuting patterns (Armstrong–Taylor 2000, LeSage 2008). Nevertheless, similar spatial externalities do not exist during monetary contraction phases.

We argue that two important points are noteworthy. First, the three well-known channels are not robustly evident (partially or weakly evident). While interest rates and credit channels are most persistent, these mechanisms are effective during expansionary monetary policy implementations. Moreover, certain regional properties such as demographic structure and innovative capacity are crucial. Overall, provinces with a highly industrialised economic structure, intensity of the services sector, small firms, young population age profile, and high innovative capacity can take advantage of monetary expansion shocks. Dynamic young and educated populations provide a higher labour supply that enhances employment growth. The intensity of the young group also increases aggregate demand, which stimulates employment growth. Furthermore, younger and educated populations reduce the likelihood of frictional problems in the labour market because the younger generation adapts better to the new qualifications and job incentives. Hence, mismatch problems between jobseekers and employers are observed less frequently in these cities. Second, the sources of cross-regional variation in employment growth responses during monetary tightening remain ambiguous, and understanding their nature is challenging. However, provinces based on industry and services suffer less in terms of employment during tightening regimes.

Discussion and conclusion

Monetary policy and its links to the economy's real side have received significant interest among scholars and policymakers. Notably, monetary policies that target monetary objectives directly and indirectly influence real economic activity. Meanwhile, there are careful considerations on the long- and short-run nature of the monetary policy's reflections. Monetary policy concerning price stability would indeed prefer tools that might hamper economic growth in the short run (interest rate hikes). Nevertheless, stability in prices has temporal spillovers in the mid- and long term by decreasing uncertainty and bringing financial stability, which will positively impact economic activity. Putting these discussions on one side, in this study, we try to examine to which extent monetary policy shocks can influence employment in the short run at the possible local level in a developing country with persistent local disparities. We argue that the growing importance of regional differences and local solutions brings new questions to understanding the spatial dimension of monetary policy. Therefore, nationwide monetary policy shocks are naturally exogenous at the local level (especially in labour markets). It is reasonable to assume that local labour will be influenced. However, the extent to which other social and fiscal policy tools are required to smooth out the adverse effects of monetary policy shocks is usually under researched (Anagnostou–Papadamou 2012).

This study aims to shed light on how monetary policy can influence local economies through employment growth at the regional level in Turkey. We examine how Turkish regions respond to monetary policy shocks by incorporating the spatiality of regional responses and the main drivers of provincial reactions to monetary policy. The results of our study indicate three main conclusions along with crucial policy implications.

First, the result that provincial employment responses are considerably heterogeneous implies a more challenging task for central banks than initially understood. In addition to the classical problems that central banks may face, such as inflation persistence (Fuhrer–Moore 1995), liquidity traps (Krugman 1998, Keynes 1936), nominal rigidities (price stickiness) (Blinder 1994), and wage rigidity (Tobin 1972), regional heterogeneity should also be considered. Indeed, there is an accelerated need for specific employment programmes on the fiscal side and social policies for some provinces that can hardly maintain employment growth in response to monetary expansion and contraction. Employment subsidies such as tax exemptions, social security aids, and related subsidies should be directed at the provincial level. Labour-intensive sectors should be directed to these places to stimulate employment growth. Reforms in a heterodox manner, such as rearrangement of labour market institutions, should be achieved such that all regions benefit from monetary expansion and protect themselves from contraction.

Second, to estimate the asymmetric responses accurately, one needs to separately analyse the effects during the monetary tightening and expansion periods. We observed that responses are considerably diverse during the monetary expansion or contraction periods. Ignoring this fact may create seriously biased results. From a policy standpoint, it is possible to learn the phase-specific needs of certain regions. During periods in which interest rates decrease, some provinces cannot take advantage of a high level of liquidity in markets and can hardly convert it into investments and employment growth. Our findings point to low monetary policy effectiveness, particularly during expansionary policy periods for these regions. This turns out to be the case when local unemployment accelerates during expansionary periods. Fiscal policy (at the national and local levels) and local governance (municipalities) should actively stimulate job creation. This is an even more challenging task for countries such as Turkey with a centralised fiscal structure. At this stage, one should not directly focus on the possibility of fiscal decentralisation; rather, hybrid approaches should instrumentalise local administrations through various local opportunities (municipalities policy implementations, the endogenous role of universities, etc.).

Third, the responses to monetary policy evolve in a spatially clustered sense during expansions, whereas, in contractions, a non-spatial distribution is evident. We believe that this finding should promote more discussion to understand how local policies can transcend the administrative boundaries of regions.

Fourth, we understand that existing theories or hypotheses are inadequate to explain why some regions are more vulnerable to monetary policy. The hypotheses (interest rate, credit, and exchange rate channels) are not robustly (or weakly) evident in Turkey. The determinants and their significance change substantially under different monetary regimes. The determinants fail to explain the cross-regional variation in responses in tight monetary conditions. However, during the expansionary monetary stance, demographic structure (younger population) and innovativeness are important and rather new determinants (along with evidence of interest rates and broad credit channels). Thus, regions with a higher innovation orientation and young populations should be encouraged. This may be achieved by stimulating new education programmes, start-up firms, and funding related projects and promoting young and innovative entrepreneurship, innovation labs, technology development zones, technoparks, and research and development-oriented education programmes. All these results remind us that, for countries like Turkey with sizeable spatial inequalities, the influence of monetary policy on local employment might be subject to certain local characteristics. As regions' local socio-economic and fiscal features differ, it is plausible to argue that the outcome of monetary policy in the short run is conditional on certain properties of regions. In a topography like Turkey with wide regional disparities, this fact decreases the expected positive influence of monetary policy (i.e. expansion) on local and national economies.

In summary, it is challenging for monetary policy to be effective for economic growth and local development in highly heterogeneous environments. Additionally, the long-run certainty enhancing the role of monetary policy is beyond the scope of this study. However, our findings indicate that fiscal and social tools are required to smooth the possible direct and indirect impacts of monetary policy shocks. We believe that this should be accompanied by complementary policy solutions, as discussed in this study. The differential impact of monetary policy and related spatial propagation mechanisms should be analysed in future studies.

INTERNET APPENDIX

Table A1 Unit root analyses for Turkish provincial employment growth

Table A2 Cumulative IRF of Turkish provinces at 24th month in response to interest rate shock

Table A3 Cumulative IRF of Turkish provinces at 24th month in response to interest rate shock in different policy regimes

Table A4 Regression results for the whole sample (OLS, SAR, SEM, SDM) in Turkey

Table A5 Results for the monetary expansion periods (OLS, SAR, SEM, SDM) in Turkey

Table A6 Results for the monetary contraction periods (OLS, SAR, SEM, SDM) in Turkey

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(downloaded: 03 February 2020)